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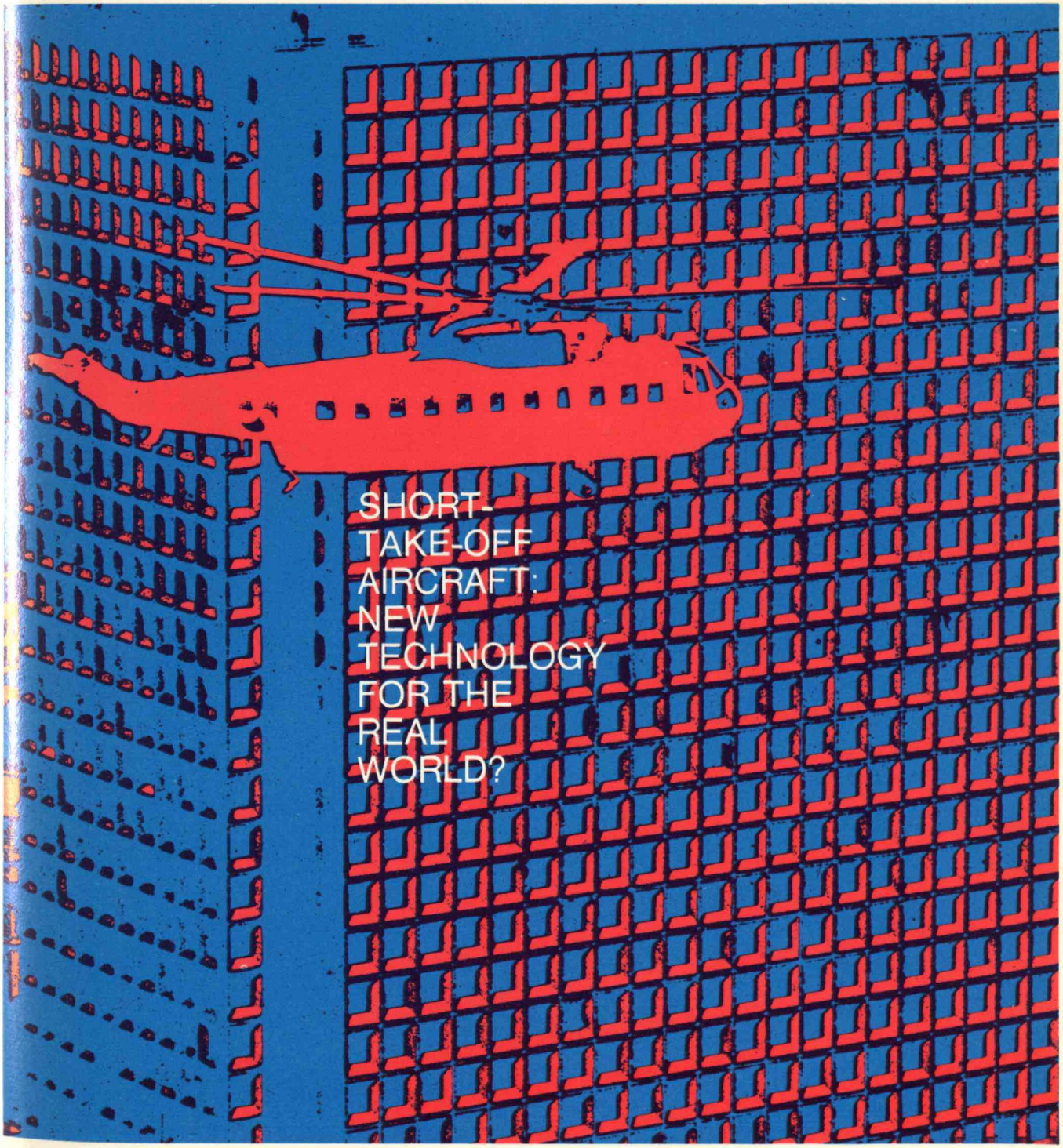

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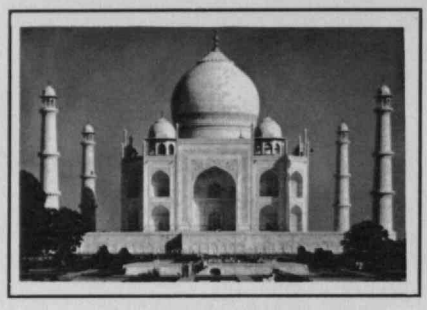

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Technology Review

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Volume 74, Number 6
May, 1972

Articles

Departments

First Line

As the newsletter of the Science and Public Policy Study Group notes, "there seems to be no limit to the *Limits to Growth*"—a reference to the prodigious public attention which has been attracted to the book by four members of M.I.T. System Dynamics Group, Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens III (Washington: Potomac Associates, 1972, $2.75)—the world model study completed at M.I.T. during the last 12 months for the Club of Rome's "Predicament of Mankind" project.

S.P.P.S.G.'s commentator is kind enough to note "that almost all the elements that seized the imagination of the press in March, 1972, were present in the *Technology Review* of January, 1971"—a reference to Jay W. Forrester's paper on "Counterintuitive Behavior of Social Systems" in that issue. A prognosticator could have foreseen the response to *The Limits to Growth* from our experience: our January, 1971, issue went out of print almost at once, and Professor Forrester's is the most reprinted and most widely republished article in the *Review*'s history. The brisk demand for reprints (@ 50¢) continues.

In this and the previous issue, the *Review* has summarized a number of the little-known substudies supporting *Limits to Growth*—and published one in full: "The Dynamics of Solid Waste," March/April, 1972, pp. 20-32.

Next Month

This issue begins a series of three manuscripts on short-haul air transportation; the series concludes in June with Rene H. Miller's study of how modern technology has made the helicopter a viable transport alternative for trips in the range of 10 to 50 miles.

As one series ends, another begins: next month comes the first of two installments of a paper by J. Herbert Hollomon and his associate, Alan E. Harger, proposing how to fill the gaps which stand between today's powerful technology and its service to preserve and extend the quality of future life.

The Dawn of Applied Research

An Editorial

President Nixon's March 16 "message on science and technology" provides a measure of how long it takes, aboard the ship of state, for a cry from the crow's nest to reach the helmsman. It takes on the order of ten years.

In 1962, in an address to the Corporate Associates of the American Institute of Physics, J. Herbert Hollomon drew attention to the contrast between the nation's rapidly growing investment in research and development and the slow growth of industrial productivity. Dr. Hollomon (then Assistant Secretary of Commerce for Science and Technology, now Consultant to the President of M.I.T.) explained this discrepancy by suggesting that the way to bring about technical improvements in civilian industries was to encourage research in those same industries, rather than—as was actually done—encouraging research primarily in other areas (defense and space) and hoping for "spin-off." He showed that the countries where productivity and G.N.P. were growing faster than in the U.S. tended to be those countries which devoted a higher proportion of their manpower to civil industrial research than the U.S. did.

Dr. Hollomon further suggested that, although the processes whereby new knowledge comes into practical use were far from clearly understood, it should be possible to understand them, and to find and remove any road-blocks that lay between the laboratory and the marketplace: "Society generally benefits only when . . . technological improvements diffuse rapidly to the less efficient firms. . . . Unlike the diffusion of agricultural technology, which was effectively accomplished by land-grant colleges and extension services, there is no special mechanism of assuring the diffusion of technology to the 3.3 million industrial and commercial firms in America. . . ." (the address was published in *Physics Today*, March, 1963, pp. 38-46).

These views bear some resemblance to the "technological revolution" platform on which the British Labor Party came to power in 1964, founding a new Ministry (of Technology) to put such ideas into practice. The same general philosophy—that a nation should adapt its research effort very closely to its perceived needs, while at the same time trying to identify and clear away the obstacles to practical application—is what is new in the President's March message. Besides selecting five areas of special need (transport, energy, natural disasters, health care and drug abuse) and two likely bottlenecks (patents and small-business capital) it mentions "a program whereby the National Science Foundation would support assessments and studies focussed specifically on barriers to technological innovation and on . . . alternative federal policies which would reduce . . . those barriers". (A White House release mentions "federal tax, patent, procurement, regulatory and antitrust policies" in this connection.)

Of course, the new philosophy is mingled with the old. The rise in funding which the President is requesting for civil research and development ($700 million) is less than the rise he is asking for defense research and development ($767 million). But such a comparison probably misses the point: which is that civilian technical progress is now promised some degree of recognition in its own right.—*F.W.*

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Letters

The Real Problems in Solar Energy

Some comments are in order about Robert C. Cowen's "Science Review" in *Technology Review* (February, pp. 5-6).

Peter Glaser's approach is indeed far out, but it is based on careful and competent evaluation of possible technology. Nobody disagrees seriously with his technical projections. No financial claims have been made which cannot be supported by fact, it is freely admitted that manufacturing and other cost reductions of a very large magnitude are necessary before the scheme is cost-competitive, and no effort has been made to obtain financial backing which is not warranted by the facts.

Aden Meinel's approach, on the contrary, seems to be somewhat nontechnical in nature. In his proposal to the National Science Foundation, in a recent presentation at Jet Propulsion Laboratory, and in stories one sees in the press, the only thing Dr. Meinel stresses about his solar surfaces is their selectivity—not their specific absorptivity or emissivity values. Since the final operating temperature of the surfaces must be much below the so-called stagnation temperature, the selectivity of the surface is not that important. It becomes much more important to have very high absorptivity than it is to have a very low emissivity or a very high a/e ratio. The radiation losses are minor. This in fact has been recognized long ago. In a 1960 N.S.F. study at U.C.L.A. (Edwards *et al.*, N.S.F. G9505) it was already concluded that selectivity makes no sense when concentrators are used.

With no justification whatever, Dr. Meinel claims that 30 per cent of the *incident* energy on the surface of the earth can be converted to electrical energy, by coupling heat collectors to a steam power plant using literally miles of liquid metal lines and heat storage systems to connect the two. There is no evidence that such a dispersed system can achieve the efficiencies claimed—which in fact are as high as those achieved by many compact coal-burning plants.

Dr. Meinel's claim that there was some sort of (sponsorship) "spell" suppressing the field of solar energy is simply nonsensical. Dr. Meinel's concept of double tubes with intermediate evacuation was patented by C. G. Abbot of the Smithsonian Institution in 1941. During literally decades, responsible people in the Solar Energy Society have tried to limit research and development work to schemes that had financial promise, or to materials which might make economic sense in specific schemes such as that of Dr. Abbot. I am quite sure that Dr. Glaser and other prominent people in the field see no "conspiracy."

Francis de Winter
Jet Propulsion Laboratory
Pasadena, Calif.

The Limits of Waste Heat

Donald R. F. Harleman's article, "Heat—the Ultimate Waste" (*December, pp. 44-51*), calls attention to an absolute upper limit placed upon power consumption by the need to radiate waste heat to space. As he points out, the waste heat in certain areas is already comparable to the absorbed (and reradiated) solar energy.

According to his table on page 45, in Manhattan the energy consumption is 6.8 times the solar energy. If all of the consumed energy, which ultimately is transformed to heat, had to be radiated locally, the surface temperature of Manhattan would rise from its present value of 60°F. to 370°F. Of course, dissipating this heat over a larger area, and thereby reducing the rise in temperature, is what Dr. Harleman's article is all about, and that is presumably what prevents catastrophe in New York. But when

one looks at the problem nationwide, it is not possible to find a significantly larger area than the whole country, so some temperature rise becomes inevitable.

If electric power consumption continues to rise as rapidly as in the recent past (doubling every decade for the last five), calculations suggest that by the year 2030—only 60 years from now—the predicted national temperature rise will be at least 21°F., unacceptably high. This in fact seems very conservative, as it assumes that the radiated heat is uniformly distributed over the entire country; actually, it is highly concentrated.

My conclusion is that while Dr. Harleman may be correct in saying of the present situation (*p. 46*) that "no climatic effects are involved," it will not be long before we begin to see such effects. In the long run, there seems to be no alternative to levelling off our power consumption if we are to avoid the inevitable climatic effects of thermal dissipation.

George B. Field
Professor of Astronomy
University of California, Berkeley, Calif.

Professor Harleman comments:

Professor Field's calculation of a 21°F. temperature increase in this country by the year 2030 is based on an assumed average radiation from the land surface of 100 W./m.^{2} He also assumes that the energy dissipation due to power production takes place only over the land area of the United States. Fortunately for the future of our children, both assumptions grossly overestimate the temperature rise. Total radiation from the earth consists of both short-wave and long-wave components, and the total is more nearly 300 W./m.^{2} Professor Field's value represents only the short-wave component. A more important factor is that in both hemispheres there is a massive heat flux from the middle latitudes toward the polar regions. The United States is big, but it covers only 3 per cent of the northern hemisphere. The polar heat flux is presently estimated to be about 5×10^{15} watts. If power production continues to double each decade, by the year 2030 it will reach 10^{14} watts or only 2 per cent of the present polar heat flux.

New Residents in "The Systems Zoo"

To the menagerie of "The Systems Zoo," appearing in the December, 1971, *Review ("Trend of Affairs," pp. 67-68),* I would add the following:

☐ The producer, who is uneasy about the systems study phase that offers so little tangible result and rushes into programming and implementation phases, producing results that fail to deal with the basic issues.

☐ The economizer, who finds the use of data already in the company information flow so inexpensive that he limits his systems to the use of existing data only.

☐ The wastrel, who fails to take into consideration the incremental cost of more complex models and would rather be exactly wrong than be approximately right.

☐ The pleaser, who uncritically accepts advice from all and produces results that, like the camel, look as if they were designed by a committee.

☐ The professional, who moves toward the leading edge of the art rather than to the heart of the problem.

☐ The job hopper, who moves so often that he need never face the implementation and evaluation of his work.

☐ The measurement avoider, who fails to build into the system measures of its own cost and performance.

☐ The tyrant, who overwhelms management with his jargon and energy and cannot distinguish between their confused acquiesence and real understanding and acceptance.

Arnold H. Berger
Computer and Information
Science Department
Cleveland State University
Cleveland, Ohio

Required Study

The gross inefficiency of American transportation was graphically displayed in "System Energy and Future Transportation" (January, pp. 31-37). The net propulsion efficiency chart (pp. 34-35) should be required study by President Nixon, Congress, the Department of Transportation, aerospace manufacturers and engineers, and all other manufacturers and designers of transportation devices now in production or contemplated. And it should also be studied by anyone aspiring to be a person mentioned in the preceding sentence.

John J. Weber, Jr.
Rancho Cordva, Calif.

Data Transmission and AUTODIN

I refer Rex Malik (*"Data Transmission: The Possible or the Conventional?" October/November, p. 10*) to the U.S. Defense Department's world-wide AUTODIN (*Auto*matic *Di*gital *N*etwork) system. Granted that this is not a commercial system available for public or private use; however, the statement, "The number of people who understand the details of store-and-forward packet switching are few" will probably garner a chuckle or two around the world. This sophisticated and highly efficient message switching system has been in operation for a number of years.

Vernon Maynard
Honolulu, Hawaii

Mr. Malik replies:

I hoped the reference would be clear from the context; I was referring to the situation in the British Isles. From what is publicly known, AUTODIN is an interesting lash-up of a variety of systems constructed in a rush. It works—but then, so does an elephant; the pace, however, is a different matter—probably, again like the elephant, desperately slow.

Some forms of store-and-forward techniques are old and well known to telegraph engineers. But I stick to the point: the number of people who understand the detail of store-and-forward packet switching at the level of this discussion are few; any form is generally quite new to people involved with computing. I would in any case hesitate to think of AUTODIN as any sort of model for a civil network, though some of the work is clearly applicable. My own American sources, within the guarded limits that they can talk, share my doubts.

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Can We Look At Space Realistically?

Science Review:
Robert C. Cowen
Science Editor,
The Christian Science Monitor

At this writing, American scientists are mapping Martian volcanos and preparing to have another go at the moon. They are proclaiming the existence of humanity to any spacefarer who may come upon Pioneer 10 when it leaves the solar system. Their activity embodies the residual momentum of a declining program.

Meanwhile, with less publicity but more enduring purpose, Russian researchers also massage new Mars data and admire the moon goodies brought home by Luna 20. Their projects exemplify the continuity of what the Library of Congress calls "a strong and growing enterprise."

The Library's recent study of Russian astronautics puts American ambivalence toward space into instructive perspective. Here is no conflict of conscience, no reluctance to include space in the national future. Military and civil utility blend in an explorational outreach that takes the solar system as mankind's natural sphere. It enjoys support that exceeds the peak level of the American program. It aims to develop whatever national strength will arise from "storming" the cosmos on a continuing basis.

America should weigh this challenge carefully as it argues the value of investing in the reuseable shuttle, and hence in the long-range future of manned space flight. My apology if this sounds like the space-race jingoism of the 1960's. I'm not concerned with rivalry so much as with the national states of mind the two space efforts reflect.

Compared to Russia: Undirected

It seems to me there's something a little sick about Americans belittling their moon program. However misplaced the priorities of that program may appear by hindsight, it has been an operational and scientific success. It has given America a reservoir of design and flight know-how which constitutes a major national asset. To throw this away in the ardor of solving "problems on earth" would be as wasteful as some critics say it was to head for the moon in the first place.

In this connection, the degree of faith the Soviets have shown in the future of space is instructive. The highest political levels have strongly supported their space program since before the first Sputnik. With two fatal re-entries and a string of lunar and planetary failures, the Russian program has known setbacks that would have sent the American Congress hunting for every rollable head in the National Aeronautics and Space Administration. Yet even the loss of three cosmonauts last spring was met with what the congressional study calls "a Soviet determination to overcome the engineering problems entailed, and to continue the existing course of space development."

Taking the measure of Russia's space program is an exercise in tortuous indirection. The Soviet Union publishes no space budget. It sketches no organization chart of the coordinated agencies that carry on the work. It defines goals with broad-brush vagueness. Yet past performance, public statements, and *post-hoc* release of many details, plus American tracking data, help skilled analysts build a rather solid impression.

Charles S. Sheldon II, senior author of the congressional study, has made a reputation as one of the most astute among such observers. He claims to use only publicly available material in this report, which was prepared for the U.S. Senate Committee on Aeronautical and Space Sciences. Nevertheless, he and his colleagues illumine that material with background knowledge from classified defense data.

Trying to put numbers on Russia's space spending is especially tricky. You have to use different effective exchange rates for different sectors of the economy. This makes ruble-to-dollar conversions capricious. Comparisons between programs can be misleading. With this caveat, the study uses Defense Department analyses of the Soviet economy to try to estimate the space effort from the economic activity it involves.

Their Strong and Sturdy Pledge . . .

In absolute terms, the analysts believe Russia's program has been getting fairly steady support at an equivalent of about $5 billion. In relative terms, that funding amounts to perhaps two per cent of the Soviet G.N.P. The American program (including the military) peaked at about one per cent of G.N.P. It's now closer to half that value. And in terms of what Russia gets for its space ruble, the study says the "total level of Soviet space activity and total level of hardware commitment is running higher than did the U.S. program at its peak in 1966."

Manned flight enjoys a large measure of the commitment. Although Russia has disavowed the old "moon race," there's many an indication it cherished hopes of being first in lunar exploration until about 1969. Teething troubles with a giant rocket, which has yet to be perfected, wrecked the time table. Then Eagle landed at Tranquillity Base to foreclose the issue. Since then, the Soviets have been extolling the virtues of unmanned lunar probing. But Dr. Sheldon says there isn't a whiff of an indication that they have abandoned manned lunar exploration.

He thinks that, in their way and their own time, the Soviets could well head moonward. That time, he suggests, could come later in this decade—perhaps when American competition has ceased and the giant rocket has become operational. Probably designed for a considerably higher thrust level than the Apollo-Saturn launching rocket, this one would supply the lifting power the Russians need to get an expedition to the moon. The rocket that sent unmanned craft around the moon can't cope with the added weight of landing equipment.

Certainly, the Soviets have a level and sophistication of effort to mount such a program. They could do it in addition to the space station now so clearly in their immediate plans. As Dr. Sheldon notes, unmanned exploring with Luna drills and roving Lunokhods has always been part of what Soviet planners envision as the "orderly" way to lead up to manned exploration. These planners have consistently talked of manned flight as a progressive development that starts with earth orbit and leads on at least to Mars. Dr. Sheldon believes we should take their "dreams" seriously as long term goals in a continuing program. He thinks the Soviets could very likely send out a Mars expedition in the late 1980's or the 1990's. They don't appear to think of this as a "gee whiz" adventure so much as a logical extension of human activity in which they want to stake a substantial claim.

. . . for Civilian and Military Good

Meanwhile, this cosmic outreach is woven into a determined program to make space development pay off in practical civilian and military ways. Dr. Sheldon foresees an upturn in Soviet weather and communication satellite activity over the next few years. He notes, also, the heavy military development that, among other things, appears to include fractional orbit bombs and inspector-destructor satellites. America has yet to get seriously involved with this kind of weaponry.

When it comes to general space probing with satellites and planetary scouts, Russia seems to be boosting its activity every year while America languishes. This shows up in a mere count of launchings, let alone in the missions and sophistication of such advanced craft as the Venus and Mars landers. "The level of activity currently runs ahead of the corresponding level of work in N.A.S.A.," the study reports. It observes pointedly that, while America used to take voluble pride in making the larger number of scientifically significant space contributions, even that leadership "seems likely" to go over to Russia.

There's plenty of material here for anyone who would like, once again, to cry "wolf." But that would be to draw the wrong lesson from this valuable report. America has suffered from this panic approach for 15 years. In the late 1950s and early 1960s, it should have developed a space program in terms of its own national needs, its own vision of space destiny. Instead, official indifference to space turned into a sense of competition. America's space program unfolded as reaction to Soviet initiatives. When Apollo 11 killed the sense of rivalry, the emptiness of such a space policy left the program spiritually bankrupt. Discerning no clear national purpose, is it any wonder many people consider space a costly boondoggle?

Can't We Be As Thoughtful?

America badly needs to do the basic thinking it has neglected for a decade and a half. It needs a long-range space rationale that makes sense in terms of its own opportunities and necessities. And it needs this definition to use effectively the space flight capacity it has already acquired.

That capacity could easily leak away. N.A.S.A. Administrator James C. Fletcher points out that America has already destroyed the industrial base of the Apollo program. Hundreds of thousands of highly trained people now are dispersing into other jobs. He says N.A.S.A. hopes many of them can be put to work on the shuttle so as not to lose practical space design know-how.

"Hopefully," he says, "we won't have to go through the entire long process in developing shuttle know-how that we did with Apollo. But if we wait too long with the shuttle, we may lose so much basic know-how that we will have to do this. That would be a dangerous loss."

I don't want to make a case for the shuttle or any other particular N.A.S.A. project. But America does need to consider its space future realistically. It should not throw away hard-won capacity as it searches for meaningful long-range goals.

It shouldn't let misconceptions about diverting resources from human needs on earth mislead it either. Homer Newell, N.A.S.A. Associate Administrator, aptly put that question into its budgetary context in an editorial in the journal *Science* last year. Commenting on the 1972 Federal budget, he noted, "The funding proposed . . . for the entire space program ($3 billion) is a very small fraction of the funding that is proposed for efforts to ameliorate societal problems today ($90 billion). The real need is not so much for additional dollar attention as it is for attention of a different kind. Ideas, new approaches, and new insights into the wise management and utilization of our human and natural resources are what is required."

To emasculate the space program would do little to meet this kind of need. Meanwhile, Russian planners apparently see more to be gained in space than headlines and scholarly papers. Is America any less likely to benefit from a vigorous, on-going space program?

Cutting the Legs Off Section 102

Washington Report:
Victor Cohn
Staff Writer,
Washington Post

How deep is the country's commitment to saving the environment?

The first shots have been fired in what could be the greatest test yet. The target is a clause—Section 102—of the National Environmental Policy Act of 1970, but the issue is more than this set of words. It is the desire for electric power, oil, roads, dams, and highways vs. the wish for a cleaner world.

Congress passed this act in December, 1970, with its principal author, Sen. Henry M. Jackson (D-Wash.), hailing it as "the most important and far-reaching environmental and conservation measure enacted by the Congress." President-elect Nixon had opposed what he considered its main feature: establishment of a White House Council on Environmental Quality. But when President, Mr. Nixon swiftly and ceremoniously signed the act, stating that the 1970s "absolutely must be the years when America pays its debt to the past" by reclaiming the environment.

Neither President Nixon nor Sen. Jackson, it appears, had correctly gauged Section 102's potential. It merely required that federal agencies proposing any "major" legislation or project first study and then release "a detailed statement" on environmental impact.

The main result, it was felt, would be to make environmentally unconscious folks like the Army Engineers and the highway builders do some thinking and public reporting. The section did not say a project could not go ahead, however horrendous its effect. It merely said, "Tell the public about it."

A Particularly Effective Law

But because agencies have resisted telling, or telling quickly enough, or fully enough, or truly considering environmental effects, Section 102 has become the environmentalists' mightiest legal weapon. It has enabled them to go into court to block or delay project after project—nuclear power plants, the Corps of Engineers' Cross-Florida Barge Canal, the Corps' Gilham Dam across Arkansas' Cossatot River, the Tennessee-Tombigbee Waterway, federal sale of oil and gas leases off Louisiana and, for some two years, the great Trans-Alaska Pipeline. Each case has dramatized the price of progress vs. environment. Some, like the Florida barge canal, may be permanently dead. Even the worst of projects, when it finally goes ahead, will probably be better environmentally for the close examination.

But now Rep. Chet Holified (D-Calif.), chairman of the House Government Operation Committee and most powerful member of the Joint Committee on Atomic Energy, says the Environmental Policy Act's "laudable purposes" have been thwarted by unreasonable court interpretations and agency over-reaction; and that "a procedural paradise" has been created for intervenors "who wish to delay progress in the name of environmental protection."

In other words, one might read these complaints as admitting the environmental crusade is more than talk. The public may face blackouts or brownouts this summer as a result of delayed nuclear power plants. It may even be jolted into asking: what environmental price should we pay for more electricity? A U.S. District Court has even held that the Corps of Engineers—now pressed into a more environmentalist role—may not issue permits for discharges into waters without permit-by-permit impact statements.

With Unexpected Results

A shaken White House in February prepared a nine-page "draft" of possible Section 102 and other changes. The letter was supposedly confidential, but a Congressional committee aide called it "about as confidential as me standing on second base at RFK Stadium and doing a jig." Environmental Protection Agency chief William D. Ruckelshaus, whose name was merely printed on the letter, said he had not seen it, and it was "not the Administration's official position."

However, the chairman of the White House Council on Environmental Quality, Russell E. Train, had plainly signed it. The letter said the Administration would like the Act amended to exempt all "environmental protective regulatory agencies." When this word got out, Train said he personally wanted to exempt only water-quality agencies.

Sen. Jackson himself has expressed concern over environmental extremists, and in March—while off campaigning in Florida—he permitted Sen. Howard M. Baker (R-Tenn.) to chair a set of hearings to begin to explore Section 102's application, especially to licensing and regulatory agencies.

Sen. Edmund S. Muskie (D-Maine), also off campaigning, quietly accepted a new water-pollution bill amendment to exempt the A.E.C. from Section 102 requirements on water pollution effects of new nuclear power plants. Sen. Muskie heads the Senate Air and Water Pollution Subcommittee. Sen. Baker played a leading role in persuading Sen. Muskie on this.

Sen. Muskie said with seeming logic that if nuclear (and other) power plants must obtain water-quality permits from *water-monitoring* agencies, "there is no reason for the A.E.C. to evaluate independently the thermal or other water-pollution effects . . ."

The problem is that the new water-quality legislation that emerges from Congress may wind up giving state agencies the primary responsibility. Some states do a good job; others just want industry, whether the water winds up clean or dirty.

Next chapter. In late March the A.E.C. asked Congress to give it temporary authority for speedy "interim" and "limited" licensing of atomic plants for "partial operation" in an emergency or "other situation" in the public interest. A.E.C. Chairman James Schlesinger called the request urgent to prevent certain or possible power blackouts or brownouts this coming summer or winter in Illinois, Iowa, Michigan, Wisconsin, the New York area, Colorado, and Florida.

"No One Wants To Hurt . . ."

This new A.E.C. authority—it was explained in reluctant legalese, not the blunt words of this paragraph—could really mean a license to operate at anything up to 100 per cent capacity. No full Section 102 impact statement would be required, and—unlike other A.E.C. activities—there need be no public hearing, though any objectors might submit written affidavits. This authority would expire on July 1, 1973, finally, but any operation decreed earlier could continue as long as the A.E.C. decreed an emergency.

Mr. Schlesinger was strongly backed before the Joint Atomic Energy Committee by the Administration's two top environmentalists, Mr. Train and Mr. Ruckelshaus. No one, it was explained, wanted to gut or hurt the Environmental Policy

Act. "All they want," commented a listening reporter, "is to cut off its legs."

Environmentalists agreed. Some called "the real issue" public safety, repeating arguments about low-level nuclear radiation, thermal pollution and existing nuclear reactors' emergency reactor cooling systems—which, we have learned in the past year, may be inadequate.

But Joseph Karagansis, a cool Izaak Walton League counsel from Chicago, took on the A.E.C. on its own ground: expeditious planning and procedure. In the most impressive testimony of the Joint Committee's brief, hastily-called hearings, he said: (1) The power plant situation that the A.E.C. called most critical—two new, still-idle reactors at Quad Cities near Chicago—could be solved by abbreviated administrative procedures without changes in law; (2) the Quad Cities delay was not caused by "environmental obstructionists" (those suing the A.E.C. over its impact statement) or the aroused Illinois and Iowa state agencies that were also blocking the plant's operation, but by failure of the utilities concerned to install the best possible water-cooling technology.

Karagansis' points were not refuted. They were not really discussed.

Nor was his equally important point, which no cold-blooded observer of the Washington scene can really doubt: weakening the Environmental Policy Act would "open the floodgates of environmental regression," with a parade of agencies like Interior and the Forest Service soon asking exemptions from this and other laws.

Within days the Quad Cities fight ended in compromise, as the utilities agreed to build a $30 million closed-circuit cooling system to protect the Mississippi River from thermal pollution. Some sensible adjustments may be necessary in the Environmental Policy Act—the current crisis was caused in part by an unrealistic court decision telling the Engineers they must issue a separate environmental statement on each of a current back-log of 21,000 applications.

The problem will be to protect the heart of the Act, not just this year but next, when—election year over—a lot of representatives of the people may be a bit less reluctant to make environmental "adjustments."

The Russian-Finnish Computer Alliance

European Report:
Rex Malik

A Finnish joke has it that Finland's President Urho Kekkonen received an urgent message to visit Moscow. As in that old saw—when Moscow sneezes, Helsinki catches a cold—President Kekkonen quickly packed his bags and flew. He arrived at the Finnish Embassy expecting all chaos to have broken out. Instead, nothing—for three days, nothing. Somewhat perturbed, the President asked one of the Embassy staff to telephone a Kremlin contact to try to discover how he and the Finns had erred. "Oh, it's nothing like that," said the contact. "There's nothing for your President to worry about. Our leaders have no wish to be impolite, and I must apologize for the three-day delay. It is just that they are somewhat embarrased. They have a question to put to your President, but they are not quite sure how to go about it. Between you and me, however, there's no problem. The question is, How do you manage your affairs so as not to annoy your big neighbor in the East?"

The short answer is that the Finns stay ostentatiously neutral while making themselves useful—quietly, without much fuss or publicity. The latest example has to do with computing. It comes under a blanket agreement of the Organisation for Technical Cooperation between the USSR and Finland, and is the result of a tour of Finnish computing establishments.

Two years ago the leading Russian Government computer specialist, Academician A. A. Dorodnycin, touring Finnish computing establishments, suggested that there should be a joint exchange of information, and this led to an agreement between the Russian Academy of Sciences and the Finnish Data Processing Association. It provides for joint symposia, exchange visits between countries by study teams, and exchanges of research and teaching staffs.

Why should the Russians want to sign an agreement on computing with—of all people—the Finns? And, at that, an agreement expected to be more than another of those friendship exchanges which lead to great consumption of time, whiskey, vodka, and diplomatic courtesies? Finland, after all, has less than 300 computers installed, has no computer manufacturing industry (except for one new and very small offshoot of an engineering company which is working on the design and manufacture of a small process-control computer), and even lacks an independent software industry.

Why, in their turn, should the Finns wish to make an ally of Russian computing skills? The Finnish attitude to Russian computing differs quite radically from that generally found in the West, where the comment generally has long been that the Russians are backward, lacking both the software and hardware required.

Senior Finnish professionals are very convincing: what the Russians can find in Finland is something they find it difficult to obtain from many other countries: know-how and expertise almost directly relevant to the Russian situation.

The relevance which is the point at issue arises from the Finnish (and Scandinavian) way of organizing society —a way with which the Russians have some basic sympathy. It is the way of the cooperative enterprise, of central planning and central organization of the machinery of society. The ends may be different, but the mechanics, should the Russians elect to install and use them, could be very similar. What the Finns then provide is a ready source of expertise which fits; the Finnish methodology is applicable in Russia.

Computing in Finland

The key Finnish computing unit is the State Computer Center, the country's largest center of advanced computing expertise. It is important because, by act of the Finnish Parliament, it has powers over all government computing, excluding defense and social security. No part of the government can move without its approval. The Center is involved in national budgeting, forward planning, and resources modelling. It is also the country's largest commercial bureau, doing quite sizable business with private organizations. But the Center's real strength lies in the application of computing to administration, where it has extensive experience in the creation, upkeep, and handling of large files.

It is precisely in these administrative areas that the Russians are weak. This is made clear by those Finns who have been involved with the agreement: they are convinced that, though both countries have much to learn from each other, it is the Russians who will end up gaining most out of the exchange. The Russian strengths, say the Finns, are science-based. Their mathematical expertise has always been high, and their modelling expertise is considerable. What is more, being essentially practical, what the Russians do is used. Thus a modelling exercise concerned with the growth of Talinn and its suburbs very quickly became a reality: the suburb was built.

Where the Russians are weak is in business-type software—the software required to create administrative systems and others which could lead in the direction of what has been called a management information system.

Their lack of expertise and experience means that the Russians have yet to resolve a number of problems concerned primarily with the collection, handling and verification of large amounts of data which have been solved successfully elsewhere. And the Russians must succeed at this level if they are to complete some of the large systems that they want to create (see *Technology Review* for December, 1971, p. 67).

Matching Weakness to Strength

It seems a situation almost perfectly made for the Finns, and over the next few years we shall surely see a substantial trade growing in Finnish expertise. It will not be all one way, however—at least not in ideas. Though the Russians are now developing and building a general purpose computer series, R.J.A.D., which is compatible with the I.B.M. 360 and the System 4 (the British version of R.C.A.'s Spectra 70), most Russian hardware remains comparatively old-fashioned. But do not be too quick to dismiss the faithful old ways. "We were at the Institute in Talinn" said one disbelieving and half-envious Finn. "There was this old monster sitting there quietly chugging away—and no ventilation system. 'And what,' we said, 'do you do when it gets hot?' 'We open the windows,' they said. They weren't worried about the machine; their concern was with the people!"

The Military As Civil Engineer

Book Review
Theodore M. Edison

Dams and Other Disasters
by Arthur E. Morgan
Boston, Porter Sargent, 422 pp., $7.50

In his farewell address, President Eisenhower warned that "we must guard against the acquisition of unwarranted influence . . . by the military-industrial complex." The urgency of that warning is vividly demonstrated by Arthur E. Morgan in *Dams and Other Disasters,* which contains a detailed, critical analysis of several major projects that involve the Army Corps of Engineers and its powerful "ally" the National Rivers and Harbors Congress (renamed Water Resources Congress, upon merger with Water Resources Associated, in April, 1971).

Dr. Morgan first examines the education that many Army Engineers receive at West Point, and he concludes that the training there tends to generate characteristics that are not appropriate for civilian engineers. In the heat of battle, commanders may have to act without the benefit of consultations or thorough studies of alternative plans; so *for war purposes* there may be good reason to teach them (1) to make prompt decisions on the basis of relatively quick estimates of situations; (2) to stick with decisions once made; (3) to support teammates; and (4) to demand from subordinates instant and automatic acceptance of decisions, with no debate. On the other hand, much may be gained by approaching nonmilitary peacetime projects in a different way.

While Dr. Morgan mentions a number of Corps engineers whom he holds in high esteem, and while he does not deny the technical excellence of much work that the Corps has done, he still seems to feel that because of the effects of military indoctrination, the Corps should not be entrusted with non-military undertakings. In support of that thesis, he draws from the records of several famous engineering controversies and presents much evidence to show that the Corps not only mishandled its own efforts to solve some very important problems but also did all it could to frustrate civilian engineers who were succeeding. Some of this evidence deals with instances where the Corps' procedures apparently led to much civilian hardship that could have been avoided if the Corps had been more sensitive to the environment it was destroying and had spent more time devising better ways to reach its goals.

Bitter disputes between the Corps and such noted engineers as John R. Freeman, James B. Eads, and Dr. Morgan himself are recorded in considerable detail; and the number and types of references cited show that an enormous amount of research must have gone into

(*Book reviews continued p. 66*)

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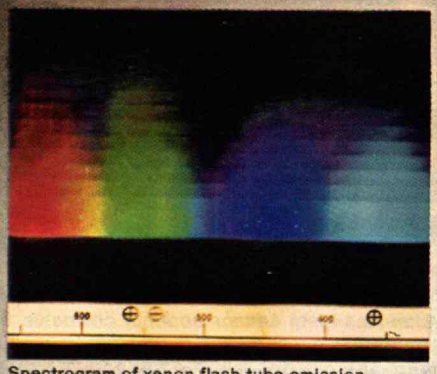

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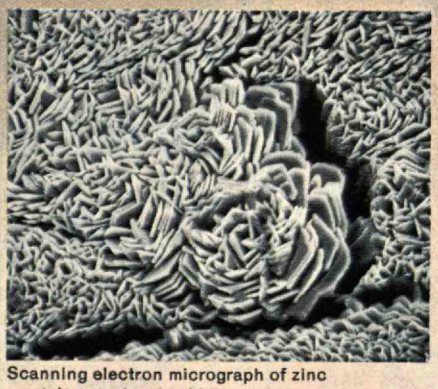

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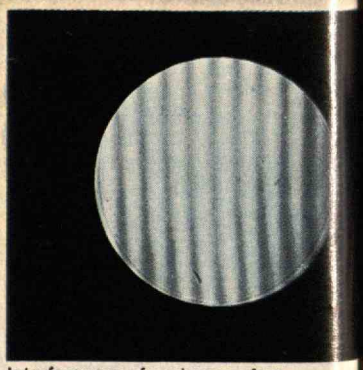

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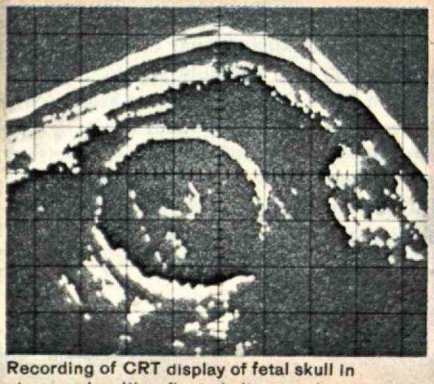

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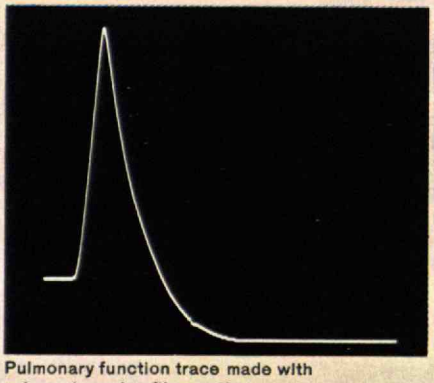

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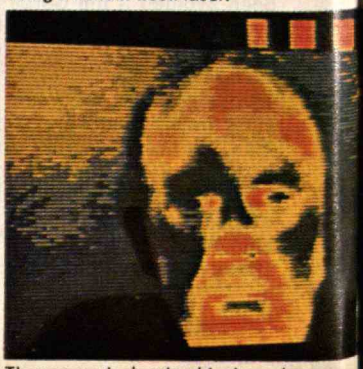
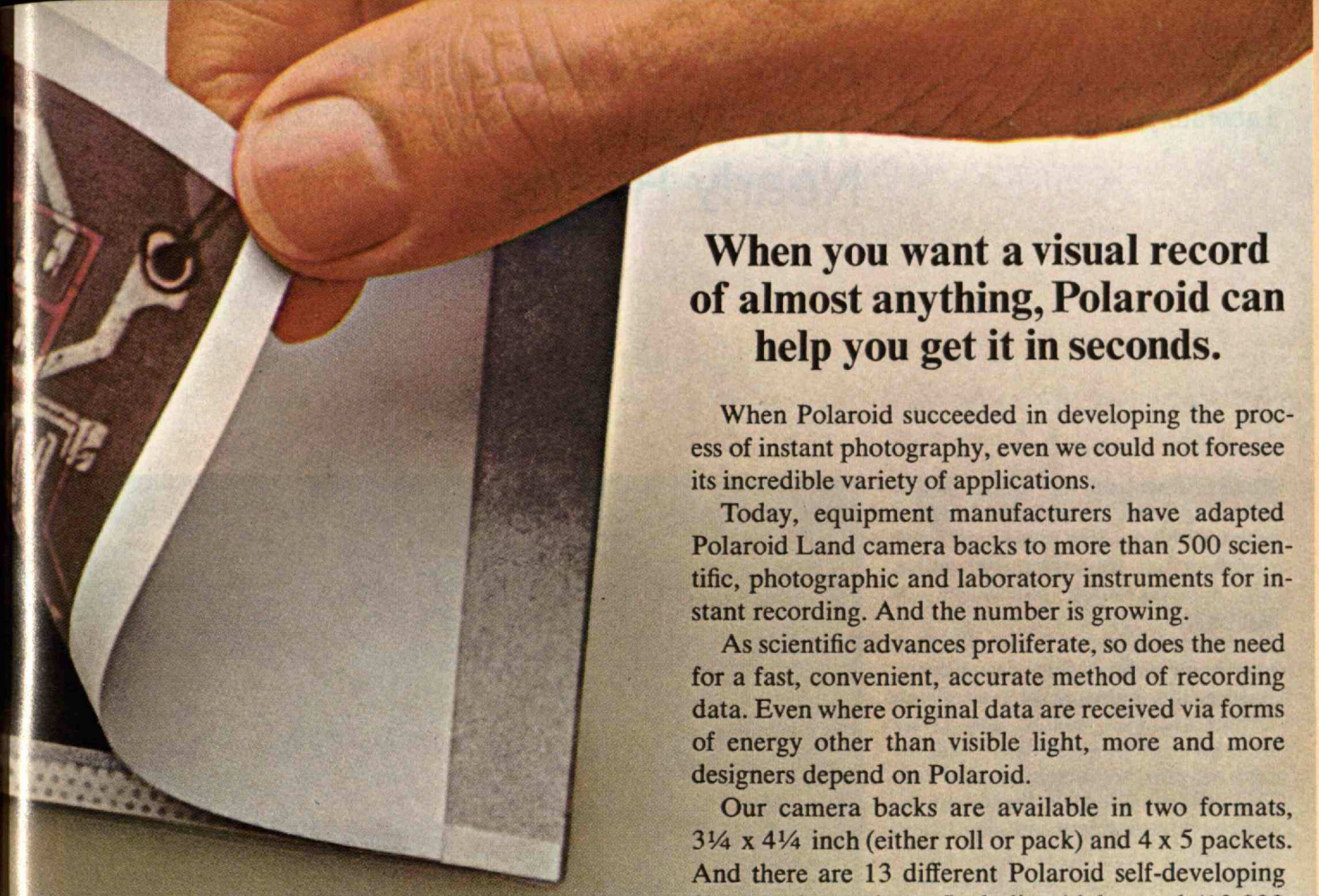


Thermograph showing blockage in carotid artery.



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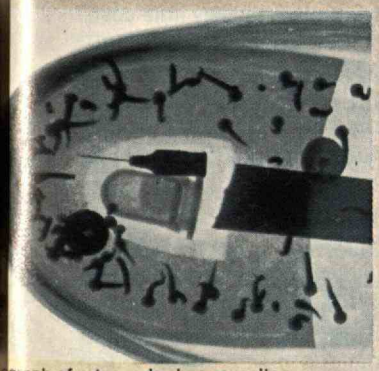
Polaroid Land Camera Backs



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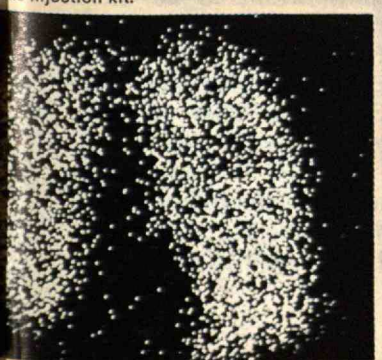

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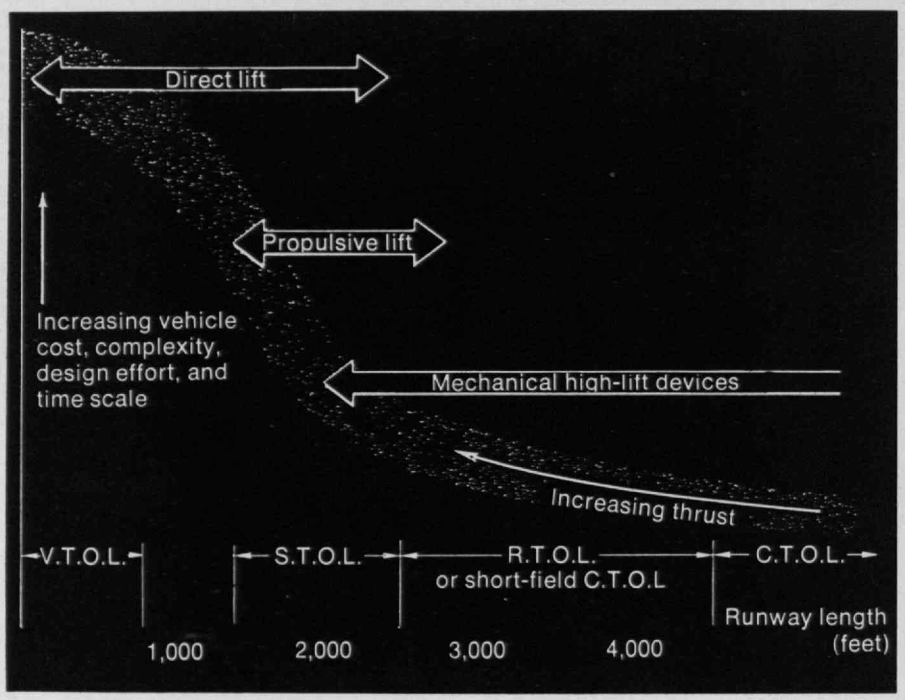
Henry B. Faulkner
Flight Transportation
Laboratory, M.I.T.

Short-Haul Aircraft: The Technology Is Nearly Ready

Future short-haul air transportation systems, based on aircraft designed to carry 50 to 150 passengers over distances of less than 500 miles, are a promising alternative to high-speed ground transportation. New technology can reduce the runway requirements and dramatically reduce the noise of aircraft. Thus airports can be smaller and closer to central cities—and there will be no need for the massive capital outlay and extended (rather than localized) investment in land and roadbed.

What is most surprising is the near availability of the technology for building these new aircraft—a matter with important implications for transportation planners.

There are several forms which these new "Q-planes" (Q for quiet) might take. Turbofan, turboprop, and propfan (a new hybrid) fixed-wing aircraft, along with various kinds of helicopters and tilt rotors are discussed below.



This chart illustrates in qualitative terms the general trend of increasing complexity, cost, and development effort required for turbofan aircraft as runway length is reduced. A promising area is indicated in the 2,500-4,000 ft. range, where a large reduction in runway length can be achieved with relatively little cost.

Turbofan (Jet) Powered Aircraft

Today's standard transport aircraft can be classified as turbofan-powered C.T.O.L. (Conventional Takeoff and Landing). It cruises at speeds greater than 500 m.p.h. and requires runways longer than 5,000 ft. Long-range transports are likely to continue to require runways of up to 12,000 ft., but now it is becoming feasible to design short-range turbofan transports to use shorter runways and smaller airports.

Initially, runway length can be reduced by simply increasing the take-off thrust and wing area of existing aircraft. Also, one can optimize the wing for maximum lift when in take-off and approach conditions rather than cruise conditions (by using less wing sweepback, greater wing thickness/chord ratio, more complex leading- and trailing-edge devices, etc.). This leads to a class of C.T.O.L. aircraft called "short-field C.T.O.L." or R.T.O.L. (Reduced Take-off and Landing). They require runway lengths between 2,500 and 4,500 ft.

As wing loading (gross weight divided by wing area) is reduced, aircraft become more sensitive to wind gusts and may become unacceptable for passenger comfort. But there is now available to help alleviate this problem a class of ride-smoothing systems which sense gusts and automatically control the wing flaps. These systems show a significant reduction in aircraft gust response for low-wing-loading transport aircraft and indicate that acceptable R.T.O.L. transports can be designed to operate on

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Henry B. Faulkner is a member of the research staff of the Flight Transportation Laboratory in the M.I.T. Department of Aeronautics and Astronautics. This article is drawn from the report of a Workshop on Short-Haul Air Transport sponsored by M.I.T. and the Office of Advanced Research and Technology of the National Aeronautics and Space Administration in Waterville Valley, N.H., in August, 1971. Other contributors to the report were B. J. Davey of the British Aircraft Corporation; Professor Norman D. Ham of the V.T.O.L. Technology Laboratory, M.I.T.; Richard Long of the Sikorsky Aircraft Corporation; T. Sills of Rolls-Royce, Ltd.; and Professor Robert W. Simpson of the Flight Transportation Laboratory, M.I.T. Mr. Faulkner completed work for the S.M. degree in the Department of Aeronautics and Astronautics at M.I.T. in June, 1970.

The technological problems which have heretofore limited the potential of short-haul aircraft, notably noise and the need for long runways, are now being resolved—with important implications for transport planners.

DeHavilland of Canada's DHC-7 48-passenger S.T.O.L. transport may be available for short-haul service by 1975 if development is pursued. It would be acceptably quiet and appears to have full commercial capabilities.

runways as short as 2,500 feet.

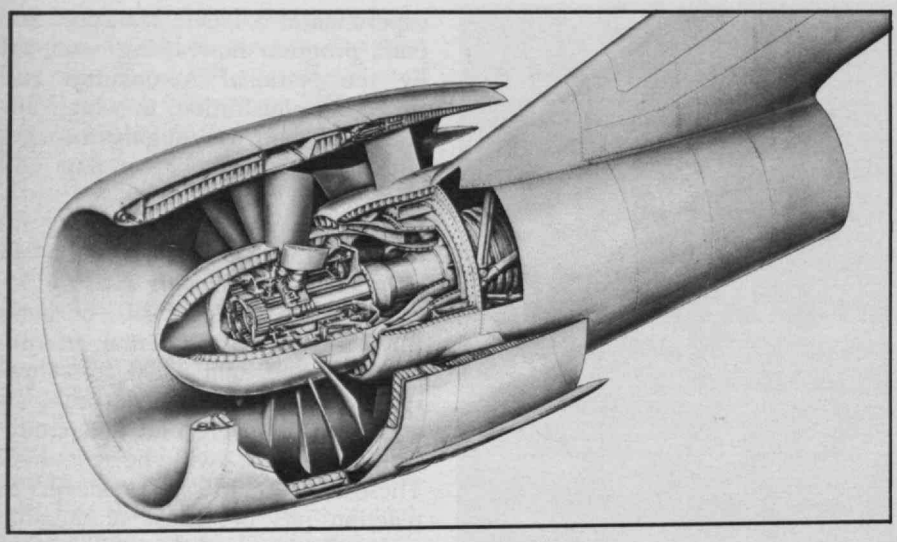
Runway lengths can then be further reduced to achieve S.T.O.L. (Short Take-off and Landing) performance by using some form of propulsive lift; i.e., the power plant is used directly to increase the lift by some means. There are various ways for achieving this; among them are deflecting the thrust of the propulsion engines, adding light-weight lift engines, and increasing the wing lift with such special aerodynamic devices as the augmentor wing, or externally or internally blown flaps. (In the augmentor wing design, air from the engine fan is piped internally through the wing and blown out at a downward angle through the narrow space between two parallel flaps; lift is increased by the jet effect of the downward-directed stream and by entrainment of ambient air which flows over the outside of the flaps. The lift of the externally blown flap is increased because not only ambient air, but also part of the fast-moving turbofan exhaust blows around it. In the internally blown flap, air is piped from the engine fan to the trailing edge of the wing and directed to flow around the flap.) All involve varying degrees of cost and complexity. For a given field length, higher lift allows a smaller wing area; this in turn improves cruise performance and thus helps to offset the extra cost of the powered lift system.

At the present time it is impossible to forecast which of these propulsive lift systems will be the best. The question may be resolved in the experimental S.T.O.L. transport aircraft program now being mounted by the National Aeronautics and Space Administration, in which aircraft with both the augmentor-wing and the externally-blown flap will be flown.

If still shorter runway lengths are required, then these can be achieved by decreasing the wing loading, increasing the powered lift, or both. But for aircraft to operate on runways shorter than 1,500 feet, low-speed stability and control problems will become severe and nonaerodynamic controls will be required. These may include such concepts as reaction jets or thrust modulation and deflection, and they will further increase cost and complexity—almost to the same level as turbofan V.T.O.L. (Vertical Take-off and Landing) aircraft.

Designs exist for V.T.O.L. transport aircraft using direct-lift fan engines, deflected thrust from the propulsion engines, or both. The gas generators for the lift fans can be integral or remote. The advantage of these concepts is that the wing and forward propulsion systems can be optimized for best cruise performance, yielding a cruise speed and range equivalent to those of current jet transports. The disadvantages are high noise and high fuel consumption in the terminal area; an automatic take-off and landing system might be required to avoid excessive fuel consumption.

Turbofan R.T.O.L. transports seating 100 passengers and requiring runway lengths around 2,500 ft. could be available by 1976, depending on the availability of new quiet propulsion engines. British Aircraft Corporation has proposed such a new aircraft (called the Q.S.T.O.L.) based on the Rolls Royce M45S en-



The drawing shows one promising concept for reducing the noise generated by a jet engine: a propulsion unit that uses something rather like a propeller—the variable-pitch propfan.

The propfan engine can be viewed as a jet engine in which the fan is particularly large and slow-moving. The bypass ratio (the proportion of the air drawn in by the fan which is diverted around the engine, compared with that entering the engine) would be anywhere between 15:1 and 30:1, as against the 5:1 or 6:1 of recent "high-bypass-ratio" engines. Alternatively one might regard the propfan as a prop-jet engine, but with a shrouded, moderate-sized propeller having an unusually large number of blades—perhaps 12. The fan is intermediate between a conventional intake fan and a propeller in a number of respects, notably its pressure loading (the pressure-difference it generates). It is geared down, giving it a subsonic blade-tip speed comparable to that of a propeller and far below that of a conventional fan.

So far, Hamilton Standard has built and run a propfan without the associated power unit. (First tests of a complete propfan engine are planned for September.) Acoustic studies of this Q-Fan (Q for quiet, of course) have yielded some new physics, and thence a new design doctrine applicable to the slow-moving fan: to minimize noise, the number of fan blades should be between 9 and 18, and the number of stator blades downstream of the fan must be even fewer. In the present design there are about half as many stator blades as fan blades—the reverse of the relationship found good for conventional fans.

George Rosen, Chief of Propulsion at Hamilton Standard, expects that the overall noise levels possible with propfan engines fitted to 150-passenger aircraft will meet the current target for near-city short-take-off systems—that is, 95 PNdB. at a 500-ft. sideline. Furthermore, the use of externally-blown flaps as a means of achieving short take-off should not create a significant amount of additional noise, since the airstream that the flaps deflect would be slow-moving.

In a recent appearance at M.I.T., Rosen went further afield, arguing that the low noise and intermediate power-density of the propfan rendered it suitable for trains, hydrofoils, large hovercraft and subsonic vertical-take-off fighters. But what caused most comment was the finding that the pitch of the blades could be fully reversed (giving a braking thrust approaching 40 per cent of full forward thrust) without cutting off the normal-direction air supply to the turbine. "An interesting device," remarked M.I.T.'s Professor W. Stephen Lewellen. "You blow air out both ends at the same time."

gine with a variable pitch, geared fan. It is possible that R.T.O.L. versions of the B-737 or DC-9 with quiet engines could also be available before 1976.

But if we require an S.T.O.L. aircraft designed for a shorter runway and an approach speed of around 75 m.p.h., then it seems unlikely that we can expect a prototype in service before 1980, following the N.A.S.A. experimental S.T.O.L. aircraft program. Similarly, a turbofan direct-lift V.T.O.L. transport seems unlikely to be available for service before 1980, and this would require a major development program during the 1970's.

Turboprop-Powered Aircraft

The same problems of increasing aircraft complexity as wing loading and runway requirements are decreased apply as well to turboprop aircraft. Because of the propeller, these aircraft are slower in cruise speed than the turbofan transports—though this may not be significant for short-haul transportation. And they generally make less noise than do turbofan aircraft.

Past turboprop transports have had low wing loadings and less comfortable ride qualities than present jet transports. But ride smoothing systems, as mentioned earlier, may solve that problem.

A number of currently-in-service turboprop transports, including the Electra, F-27, and Convair 540, could be classified as R.T.O.L. by simply reducing their authorized load capacity. The only turboprop S.T.O.L. now in scheduled service is the 19-passenger DHC-6 Twin Otter, built by DeHavilland of Canada. If development of the DHC-7 is pursued, a 48-passenger, 275-m.p.h., quiet S.T.O.L. transport can

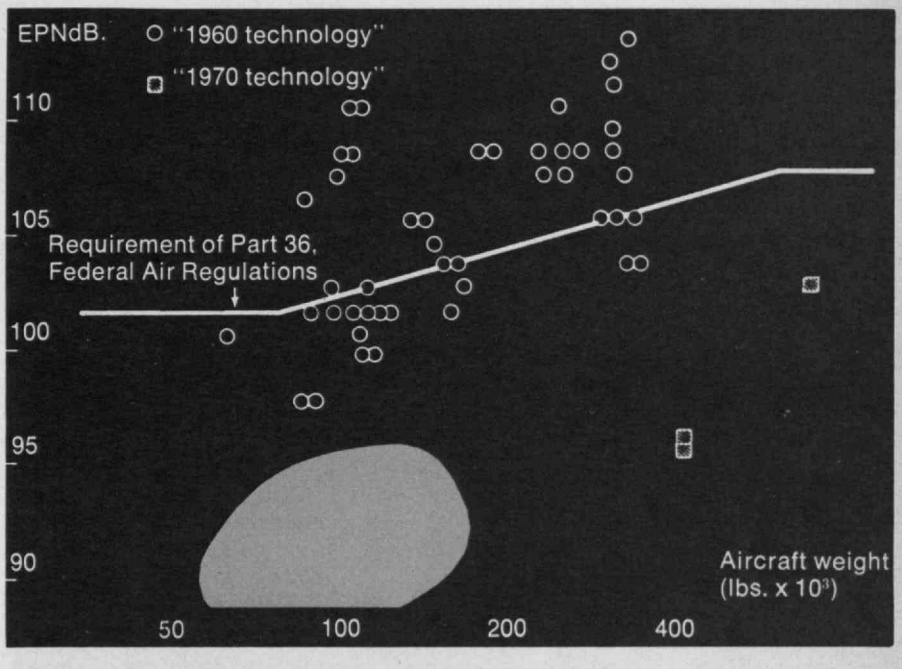
Rotary-wing transports are still in their infancy; major developments are still occurring and substantial progress can still be expected. They are worthy of future civil research and development effort.

be available for short-haul service as early as 1975.

The New Propfan Concept

In addition to those already discussed, there is a new form of aircraft propulsion which is particularly well suited to short-haul aircraft. Since its design is somewhere between propellers and current fans, it has been called the propfan, but it is now named Q-Fan, a trademark of its developer, Hamilton Standard. This engine offers good propulsive efficiencies at speeds up to Mach 0.75 or 0.80 (approximately 500 m.p.h.), which are sufficient for short-haul aircraft.

No propfan aircraft have yet been designed, but the great promise of this new engine for quietness and efficiency in short-haul service suggests that emphasis be placed on its development. Construction of testbed and flight-test engines based on existing turboprop gas generators takes 18 to 24 months. Existing transport aircraft such as the B-737 or DC-9 could be rebuilt with the propfan to provide a demonstration Q-plane. The date for introducing a new propfan transport is thus roughly 1977—if a major development program is initiated promptly.



The sideline noise of current turbofan transport aircraft during take-off at a point 0.35 n.mi. to the side of the runway is in the range of the maximum permissible under federal regulations. The "1960-technology" aircraft, some of which exceed the current limits, are of both U.S. and European design; the "1970-technology" points refer to the large, new transport aircraft now coming into service—the B-747, DC-10, and L-1011. The improvement over older aircraft is 10 to 15 EPNdB., and similar or lower noise levels are projected for short-haul aircraft now proposed (the shaded area, lower center). Note that the horizontal scale is logarithmic.

Rotary-Wing Aircraft

Whereas today's subsonic jet transport represents 40 years of progress and development, rotary-wing transports are still in their infancy; major developments are still occurring and substantial progress can still be expected. Since they offer substantial promise of quiet urban operations, they are worthy of future civil research and development effort.

The important advantages of helicopters include efficient hover capability, relatively low noise, low downwash velocities, and power-off autorotation capability (that is, after complete engine failure, the rotor can be used as a brake to make a gentle vertical landing). Their present deficiencies include relatively slow speed, short range, high cabin vibration levels, and higher initial and direct operating costs.

Present helicopters have evolved from military developments over the past 30 years, and the relatively few helicopters in commercial service are civil derivatives of military models. The last U.S. military transport helicopter development was initiated in 1962. But relatively low levels of military and industrial research and development funding continue to identify many design improvements. For example, the problem of vibration has been substantially reduced by installing a vibration absorber on the main rotor head. Experience with both military and New York Airways aircraft indicates that the absorber provides a more comfortable ride and reduces maintenance costs. Improvements in rotor aerodynamics, drag reduction, dynamic components, and turbine engines offer the potential of increased speed, payload, and range. The use of new materials, new design features for

Two advanced military transport helicopters could be developed for civil service in about two years' time. They are candidates for early intercity demonstration projects over distances of 200 mi. or less.

reliability, and new test techniques should substantially reduce maintenance on future transport helicopters designed specifically for civil use.

There are two advanced military transport helicopters which could be developed for civil service in about two years' time. One is the civil version of the Sikorsky CH-53, the S-65-40; the other is a modified version of the Chinook called the 347 made by Boeing Vertol. Both carry about 50 passengers 200 miles or more at speeds around 180 m.p.h., and both are quiet enough to win city-center acceptance at properly selected sites. They are therefore candidates for early intercity demonstration projects over distances of 200 mi. or less.

Several concepts for rotor development such as the cantilever rotor, variable-geometry rotor, jet-flap rotor, and the rigid, coaxial rotor known as the A.B.C. (advancing blade concept) are suitable for advanced helicopters with cruise speeds of over 220 m.p.h. Some of these have been successful under initial tests and are worthy of further research and development.

A compound helicopter, which has a small wing and forward propulsion as well as the conventional rotor, offers substantially increased cruising speeds. Several configurations have been flown, and one has exceeded 300 m.p.h. Current technology is adequate to build a 100-passenger compound transport helicopter with a speed of over 250 m.p.h. by 1975. The compound configuration is particularly suited for the advanced rotor concepts mentioned above.

The most promising design concept for a craft with capabilities beyond those of the compound helicopter is the tilt-rotor aircraft. This configuration has fixed wings, with a large rotor mounted at each wing tip. For hovering and low-speed flight the rotors act like those of a helicopter, but for high speeds the rotors can be tilted forward by 90° to act like conventional propellers. The tilt-rotor aircraft shares the helicopter's desirable characteristics for terminal operations: low noise, low downwash velocities, and autorotation capability. But in addition, it can cruise at speeds of up to 400 m.p.h. The tilt-rotor can have a high wing loading for improved ride since the wing is not used for lift during takeoff and landing. The process of converting from lift to forward thrust is simple and can be stopped or reversed at any time, and the conversion process can be performed at a wide range of speeds in flight.

Flight experience with tilt-rotor aircraft is limited to one experimental vehicle, the XV-3, which suffered from serious aeroelastic problems. Promising solutions to these problems have been developed and tested in a full-scale wind tunnel by N.A.S.A., but another experimental vehicle must be built and flown before transport aircraft prototypes can be designed. Since the tilt rotor concept has great potential for both civil and military applications, construction of this experimental flight test vehicle should have high priority. If this is done expeditiously, a tilt-rotor transport could be in service in the early 1980's with a cruise speed around 400 m.p.h. and a range of 600 mi.

Aircraft Noise

The C.T.O.L. jet transports which were developed and brought into service during the late 1950's and early 1960's (here referred to as of "1960 technology") were not compromised to any great extent by concern for their noise impact upon the environment. As a result, the older jet aircraft now in our civil transport fleet exceed the noise levels now required of new subsonic transports (in Federal Air Regulations Part 36) by up to 10 to 15 EPNdB. (Effective Perceived Noise in decibels—similar to perceived noise level, but corrected for the duration of the sound). Larger aircraft now coming into service (the 747, DC-10, and 1011) are within the noise limits for sideline noise during take-off. A similar improvement applies to fly-over noise during take-off, but in the case of noise from aircraft approaching an airport the improvement is smaller—roughly 5 to 6 EPNdB. for a typical landing on a 3° glide slope.

If we assume that similar improvements can be achieved in smaller aircraft, then it appears that a short-haul C.T.O.L. turbofan aircraft with "1970 technology" will produce a sideline noise in the range of 90 EPNdB. at 0.35 n.mi. There will be similar improvement in the fly-over case. The approach noise level will be in the range of 100 EPNdB., reduced from the current levels of around 110 EPNdB. But if the new transport has an improved guidance system, then a steeper approach procedure can be used and there will be a 10- to 15-EPNdB. reduction in approach noise.

Furthermore, there are a number of reasons to expect developments in turbofan technology that can reduce the noise level by at least another 5 to 10 EPNdB. by 1977. They will involve no significant economic or engine performance penalties.

For the future, and especially for V./S.T.O.L. operations, the present

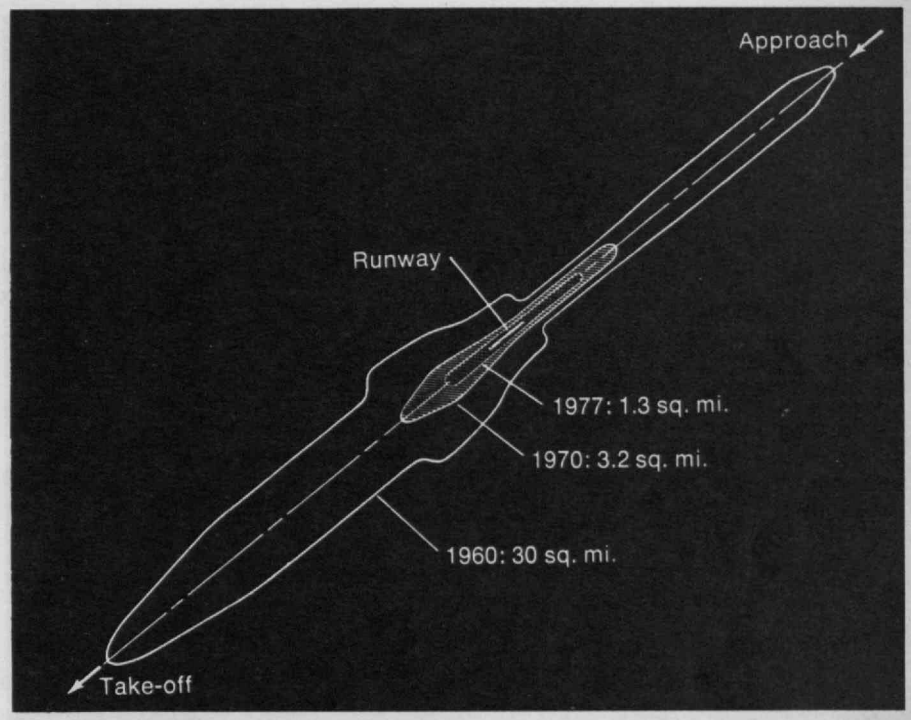
This map shows the 90-PNdB. noise "footprint"—the area over which perceived noise exceeds 90 dB.—of short-haul conventional (C.T.O.L.) aircraft of 1960 (30 sq. mi.), 1970 (3.2 sq. mi.), and 1977 (1.3 sq. mi.) on both take-off and approach. Even small decreases in noise generation are important; as the second chart (below) shows, the "footprint" area is halved for each drop of 3 to 4 PNdB. in engine noise.

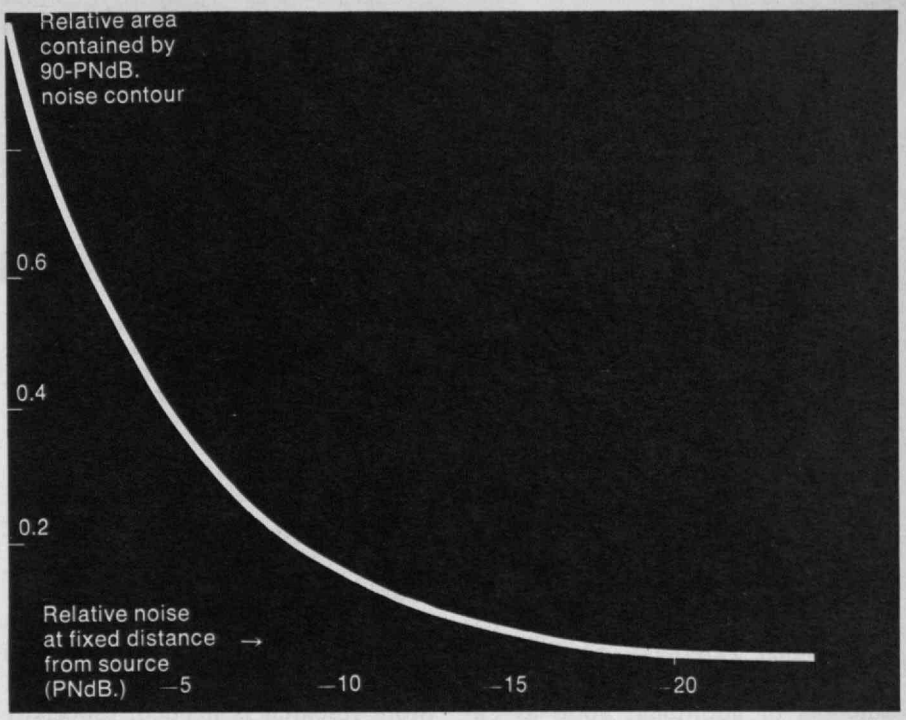
system of measuring noise at certain points in relation to a landing pattern may have to give way to the concept of maximum noise contours—an aircraft's noise "footprint." For one landing and take-off, a "1960 technology" 100-passenger turbofan transport typically exposes 30 sq. mi. of land to noise levels above 90 PNdB. The marked reduction in area, to 3.2 sq. miles for "1970 technology" and to 1.3 sq. miles for "1977 technology," is surprising but understandable: the footprint area is halved for each decrease of three to four PNdB. in engine noise. The use of footprint area as a measure of noise impact seems an attractive means of explaining to the layman the significance of noise level improvements.

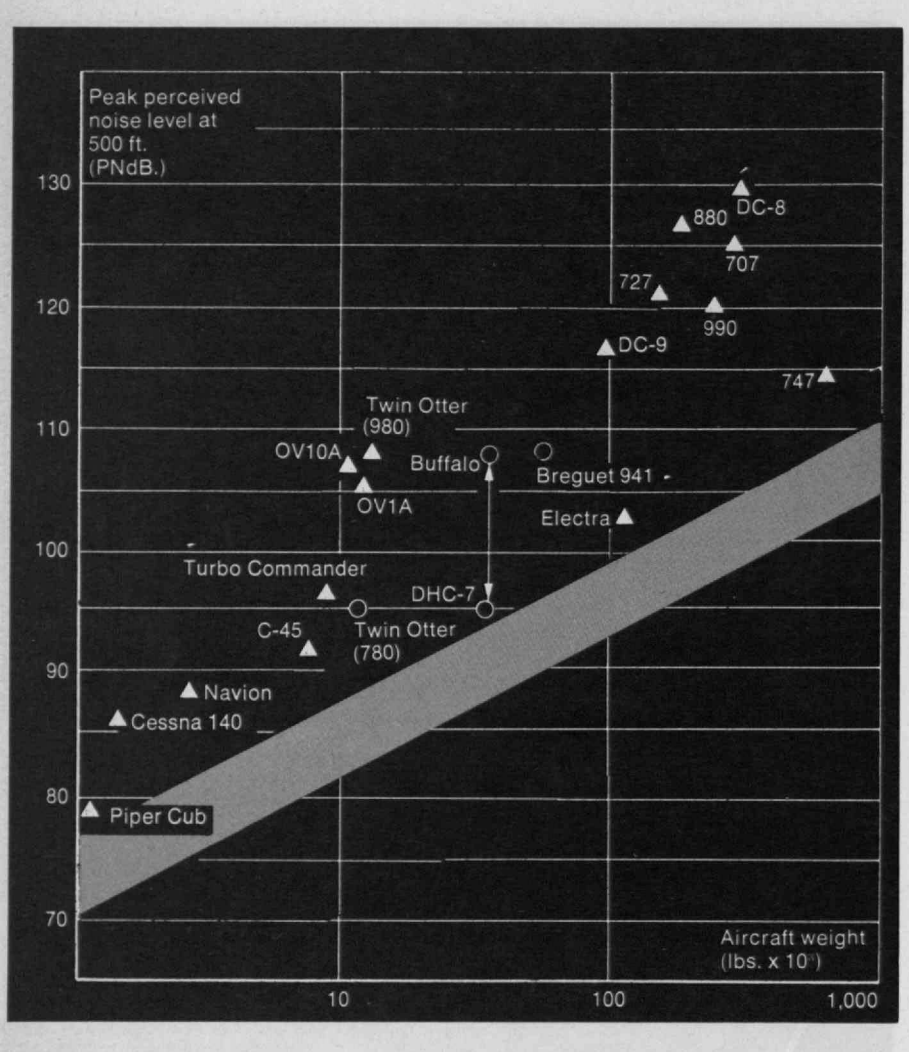
By reducing engine noise by 15 to 20 PNdB. we will shrink the footprint to less than 5 per cent of its former area. And this percentage does not depend on the particular noise contour which is considered; i.e., it is the same whether one chooses the 90-, 95-, or 80-PNdB. contour.

Since S.T.O.L. aircraft require more thrust than C.T.O.L. aircraft, they will generate more near-field noise for the same level of propulsion technology. However, the use of steeper approach and climb-out flight paths will reduce the footprint size. The net effect of these opposing trends will depend on the particular configuration, i.e., the method of generating lift at low speeds.

By using S.T.O.L. advanced mechanical flaps, it is estimated that the size of the footprint can be reduced by one third to one half for any level of engine technology. However, this prediction should be validated by research into the noise







This chart shows the perceived noise measurements at take-off for a number of well-known aircraft now in service—and indicates the typical direct relationship between noise and gross weight. Propfan and turboprop short-haul aircraft are now predicted to fall in the lower shaded area of the chart, and it is this forecast of dramatic noise reduction potential which has excited interest in propfan propulsion systems for short-haul aircraft.

reflection phenomena which may be encountered with these large wing flaps.

Preliminary N.A.S.A. research has shown that externally blown flaps on S.T.O.L. aircraft create large amounts of additional noise as engine exhaust impinges on them. There also may be reflection effects. It appears that the only way to eliminate the former effect is to reduce exhaust velocity to far below the range of current turbofan engines. More research is needed, especially with lower-velocity propulsion systems like propfans.

With S.T.O.L. internally blown flaps and augmentor wings, considerable noise is generated at the flaps at the blowing-air expansion ratios which are required. Here again, more research is needed.

V./S.T.O.L. lift fans, whether integral or remote, should benefit from many of the technical advances made with turbofan propulsion engines. As in the last two cases, the large amount of power needed during approach might push the footprint size up to that of contemporary C.T.O.L. aircraft. But lift fans permit V.T.O.L. aircraft to operate with yet steeper paths, and this might shrink the footprint area to as little as 0.3 to 0.6 sq. mi.

In summary, future C.T.O.L. aircraft can be built which have a noise footprint covering only a small fraction of the area affected today. Turbofan V./S.T.O.L. aircraft will not necessarily be intrinsically quieter simply because they are V./S.T.O.L. designs; the noise level will depend upon the characteristics of the particular V./S.T.O.L. configuration. However, low-speed maneuverability, steeper approach and departure paths, and the possibility of curved take-off and approach paths should enable V./S.T.O.L. noise footprints to be deflected away from particularly sensitive areas. It is pertinent to note that both of the propulsive-lift wing configurations proposed for the N.A.S.A. experimental S.T.O.L. aircraft have noise generation problems which must be solved before they can be used for short-haul intercity transport.

Despite the technological issues remaining unresolved, the promise of greatly reduced noise footprint area due to current and future develop-

Despite the technological issues remaining unresolved, the promise of greatly reduced noise footprint area due to current developments in turbofan propulsion technology has great significance in planning the future of air transportation.

ments in turbofan propulsion technology has great significance in planning the future of air transport, and in particular for the development of short-haul air transport. The major barrier to the future growth and development of air transport is the noise in areas adjacent to airports. The promise for quiet propulsion offered by turbofan developments is of such vital importance that immediate and full-scale development of flight test engines is mandatory in order to validate the forecast.

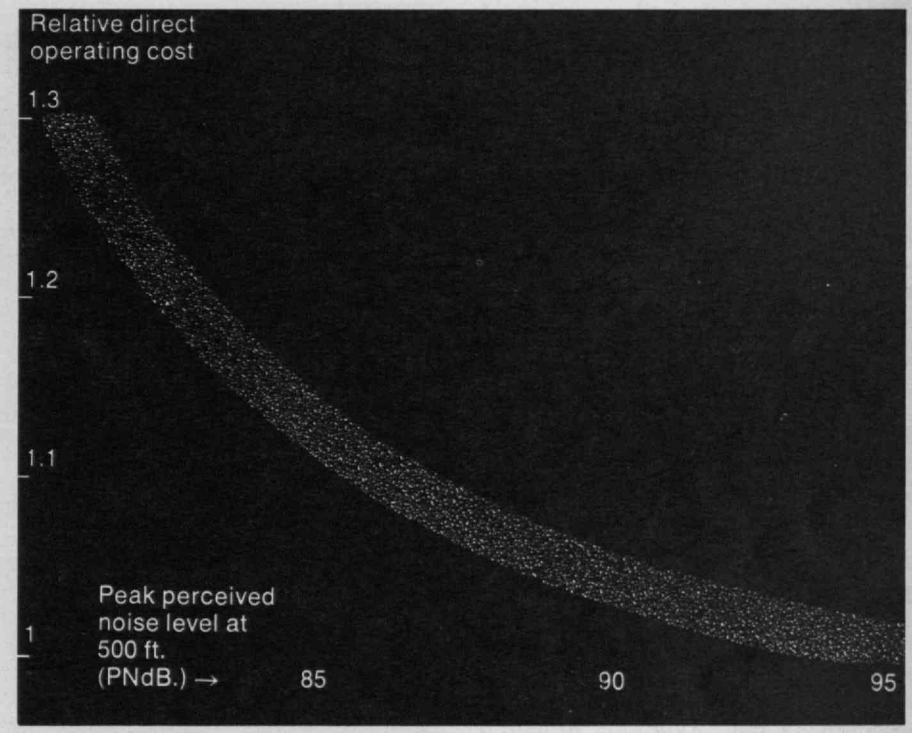
Major decisions face this nation concerning retrofitting of nacelles and engines in present fleets, retiring present fleets for newer, quieter transports, buying land around airports, etc. These decisions will be a major determinant of the future development of short-haul air transportation, and the existence of quiet flight test engines will be a key factor in making them.

Existing turboprop aircraft generally make less noise than existing turbofan aircraft. Substantial reductions in the noise from turboprop aircraft can be accomplished by reducing propeller-tip speeds. The price is only small degradations in performance for short-haul aircraft. An example of this is the 17 to 18 PNdB. difference in the noise level between the DHC-7 S.T.O.L. and a similar-size but noisier S.T.O.L. called the Buffalo. Future turboprop short-haul aircraft can be made quieter still by further reducing tip speeds and perhaps by using variable-camber propellers.

The potential noise reductions offered by propfan propulsion are large. For the same level of thrust, the propfan will make 17 to 20 PNdB. less noise than today's quiet turbofan engines such as those used on the DC-10. For a transport of 100,000 lbs. gross weight, noise levels between 90 and 95 PNdB. at 500 ft. are proposed. This is the equivalent of shrinking the noise footprint to roughly one-sixteenth its former size. Because of this great reduction, it is possible that all future short-haul fixed-wing aircraft will be powered by this kind of engine. The development of a full-scale propfan engine for flight tests deserves consideration as part of any quiet engine research and development program.

Rotary-wing aircraft are attractive for short-haul intercity operations primarily because of the promise they offer for quiet city-center operation and community acceptance. Helicopters are the only short-haul transports which can now meet a standard of 95 PNdB, at 500 ft. The Sikorsky S-61 makes 93 PNdB. at 500 ft. and has been accepted at downtown sites. The measured hovering noise of the 50-passenger Boeing/Vertol 347 is between 90 and 95 PNdB.

Hughes and Sikorsky have built quiet helicopters by modifying existing vehicles with off-the-shelf components. These aircraft have shown on an experimental basis that large reductions in helicopter noise are



In the passenger's terms, if we assume that the direct operating cost is half the total operating cost, then a 15-PNdB. noise reduction will mean an increase in ticket cost of less than 15 per cent. But in practice the direct operating cost is usually less than half the total operating cost for short-haul service, so the effect of noise reduction on total cost will in fact be less than 15 per cent.

possible. By incorporating low-noise-design features (mainly low rotor-blade speeds) in the design process from the outset, noise reduction will be possible without large increases in direct operating cost.

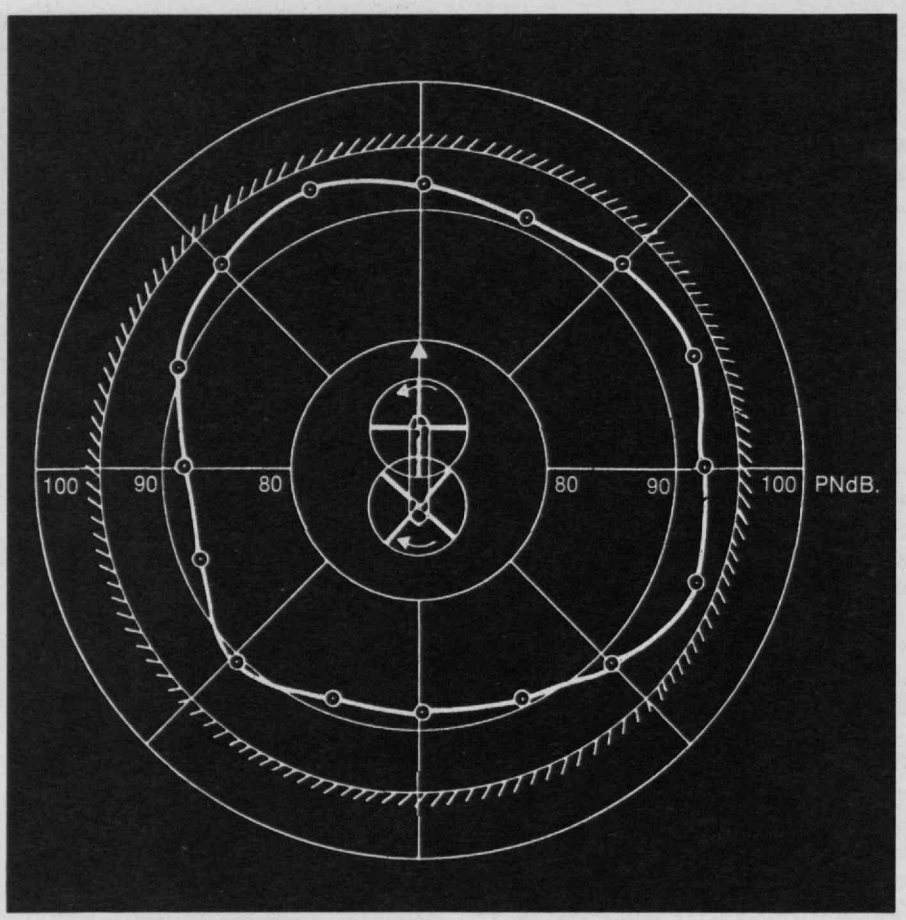
The noise reductions forecast here depend on quieting three principal sources: rotors, drive systems, and engines. Of the three, quieting the rotors appears to involve the greatest penalties. But once the noise from all sources is reduced to about 80 PNdB. at 500 ft., power plant noise will become significant and its reduction will involve much greater cost penalties.

Advanced commercial helicopters, pure or compound, can be made significantly quieter by the middle 1970's, and with continuing refinements of design, tilt rotors will be even quieter when they appear in the early 1980's. The Joint D.O.T./N.A.S.A. Civil Aviation Research and Development Study set a noise goal for 1980 V.T.O.L. and S.T.O.L. aircraft of 80 to 85 EPNdB. at the metroport boundary. It appears that rotary-wing aircraft can already achieve that goal.

In summary, present helicopters capable of transporting 50 passengers at 180 m.p.h. over 200 mi. can meet a criterion of 95 PNdB. at 500 ft. and would today be acceptable at selected city-center sites. Future rotary-wing transports will offer substantial improvement in noise performance—with a significant but acceptable increase in operating cost.

Rotary-wing aircraft are therefore the quietest type of short-haul air transport vehicles available, both now and in the future.

Since noise is the critical issue which will determine the future of short-haul air transportation, it is now appropriate that rotary-wing aircraft be considered for a much larger role than they have played in the past.

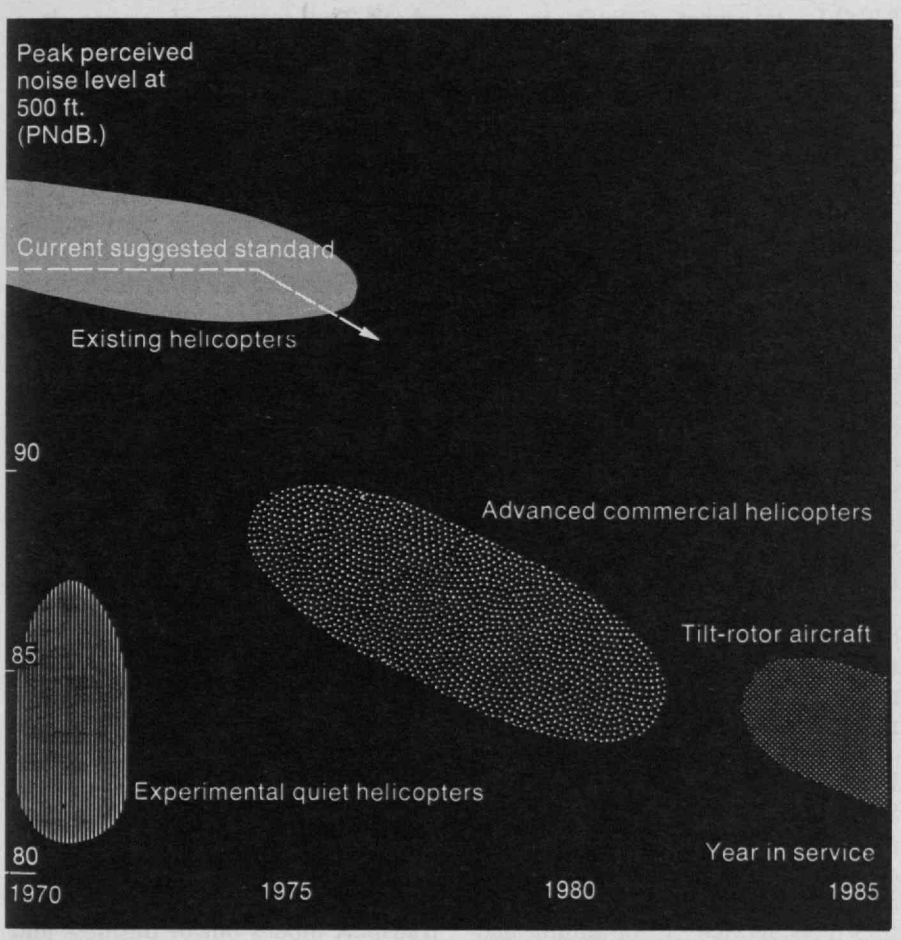


Today's helicopters are the only aircraft which can meet a standard of 95 PNdB. at 500 feet; the "map" above shows the sound levels at 500 ft. surrounding a hovering Boeing 347 helicopter. Experimental aircraft have been built which achieve substantial reductions, and the M.I.T.-N.A.S.A. summer study on which this article is based concluded (see chart on the right) that by 1975 advanced helicopters would operate at sound levels of 85 to 90 PNdB. at 500 ft. Further improvement is forecast with tilt-rotor development by 1985.

Research Recommendations

A large number of research and development projects concerned with short haul aircraft technology already are being pursued by N.A.S.A., the Federal Aviation Administration, the Department of Defense, and the aircraft industry. There appears to be much less work in progress concerned with the other elements of a short-haul system, i.e., air traffic control and airport or metroport design and operation. The M.I.T. summer study of short-haul air transport recommended greater attention to the needs for research and development

The decisions as to the best vehicle for future short-haul air systems—and, indeed, of the role which aircraft should have in our total short-haul transport system itself—cannot be made without a major commitment of research and development resources.



in non-vehicle areas to ensure the balanced development of a short-haul air system.

For example, a need exists for automated passenger-handling systems for passenger terminals for all forms of public transportation but especially for short-haul air transportation, where the expense of passenger processing is a relatively larger part of the total cost. For the public there is a need to ensure a consistent, standardized system to avoid multiple credit card devices and to prevent confusion. For the computer and transportation industries, there is a need to cross competitive boundaries to organize an initial development program which would stimulate the normal market forces in the private sector.

The need for improved automatic guidance and control systems for short-haul V.T.O.L. and S.T.O.L. vehicles indicates that research and development should be pointed towards flight demonstration of the various concepts which now exist. Stability augmentation systems, velocity control systems, ride smoothing systems, automatic take-off and landing systems, and the improvement of associated pilot displays are all worthy of development along lines which lead to applications for short-haul air systems.

The most encouraging finding of the M.I.T. summer study was the success of the efforts of N.A.S.A. and others to reduce the noise levels associated with conventional and unconventional short-haul aircraft. Yet it is advisable that further work towards even lower noise goals be continued and that new developments in engine technology by European and U.S. sources be monitored and used to redirect the quiet-engine program when appropriate.

The need for an experimental S.T.O.L. transport with which to investigate the problems of propulsive-lift S.T.O.L. systems is clear, and the program has been initiated. Because of the promise of advanced helicopters and tilt-rotor aircraft and their similar status in technological development, similar research programs should be developed for each of these candidates. These will represent a major commitment of the research and development resources of N.A.S.A. and of the nation, but the decisions as to the best vehicle for future short-haul air systems—and, indeed, of the role which aircraft should have in our total short-haul transport system itself—cannot be made until some of the uncertainties associated with these configurations are reduced.

Charles W. Harper
and Hans Mark
Ames Research Center
National Aeronautics and
Space Administration

S.T.O.L., V.T.O.L., and V./S.T.O.L.: Where Do They Fit In?

This article is an attempt to view broadly and realistically the problems and potential of V./S.T.O.L. transportation—that is, a system based on vertical/short-take-off-and-landing aircraft. It is difficult to avoid the conclusion that, despite obvious obstacles, a V./S.T.O.L. system will eventually be an important element in world transportation. The fact that we may only now be starting to make significant progress in this direction could mean that the problems are only now being understood in a proper way. The thoughts expressed here—for which we claim no particular originality—are presented in the hope that we may help to realize the true potential of V./S.T.O.L. technology by placing its elements in a single, coherent perspective.

First, what do the oft-repeated abbreviations in our title mean? A S.T.O.L. transport aircraft, in our usage of this term, has all the characteristics and capabilities of a modern short-range jet transport plus the ability to operate from short runways in congested areas, of the order of 2,000 ft. length or less, at its design weight; where longer runways are available such an aircraft should be capable of overload.

A V.T.O.L. transport aircraft has, as its normal operating mode for take-off and landing, a highly maneuverable vertical ascent and descent, like the helicopter, while having cruise characteristics and capabilities comparable to modern smaller and slower-than-jet transport aircraft. Because it normally takes off and lands vertically, field length has no significance (although ability to clear obstacles during descent has some); and any capability for running take-off while overloaded is of minor interest.

The V./S.T.O.L. transport would have the combined capabilities of S.T.O.L. and V.T.O.L. aircraft; thus, as circumstances demand, the aircraft could operate in any mode, including the conventional, to supply the best service at optimum economics—no mean feat.

We know that many different S.T.O.L., V.T.O.L., and V./S.T.O.L. aircraft can be built and flown. During the past 15 or 20 years many have been, and some have managed to survive without accident. But in spite of this we still have to say, "So what? Nobody is using them." Much effort and money have been committed, without apparent results.

Why? Are we chasing something that has no future place in transportation? Have we missed some piece of the problem? Are we out of phase with requirements, or what? The answer, of course, is a mixture of these things. Our effort here is to pinpoint some of the key issues, particularly the less technical ones, in an effort to shake out some plan that either disposes of V./S.T.O.L. as of no future use or helps point a direction in which it should be moved.

The overriding question is, "Do we *want* V./S.T.O.L. air transportation?" Without doubt, the investment on the part of both the public and private sectors will be high, so the return in services and revenues must also be high. Part of the answer can be gathered from studying the history of air transport development; part from trying to anticipate where we might go in the future.

The Years of the Jet

The phenomenal growth of air transportation in recent years was initiated by the introduction of the long-range transport, particularly the jet, which provided fast nonstop connections between the major population centers of the developed nations. In the process the airlines drove competing ground and sea transport modes out of business and brought about methods of conducting business, politics, and recreation that are wholly dependent on high-speed long-range transport. Air transportation changed, then, from a luxury "jet-set" operation to a vital link in our national activities. In 20 years it also helped to create a whole new element in the U.S. economy: aerospace grew to be the second or third industry in total employment.

An unexpected offshoot of the sweeping success of the long-range jet was low direct operating cost, which made possible the use of smaller jets, derived from the larger high-speed aircraft, for short-range

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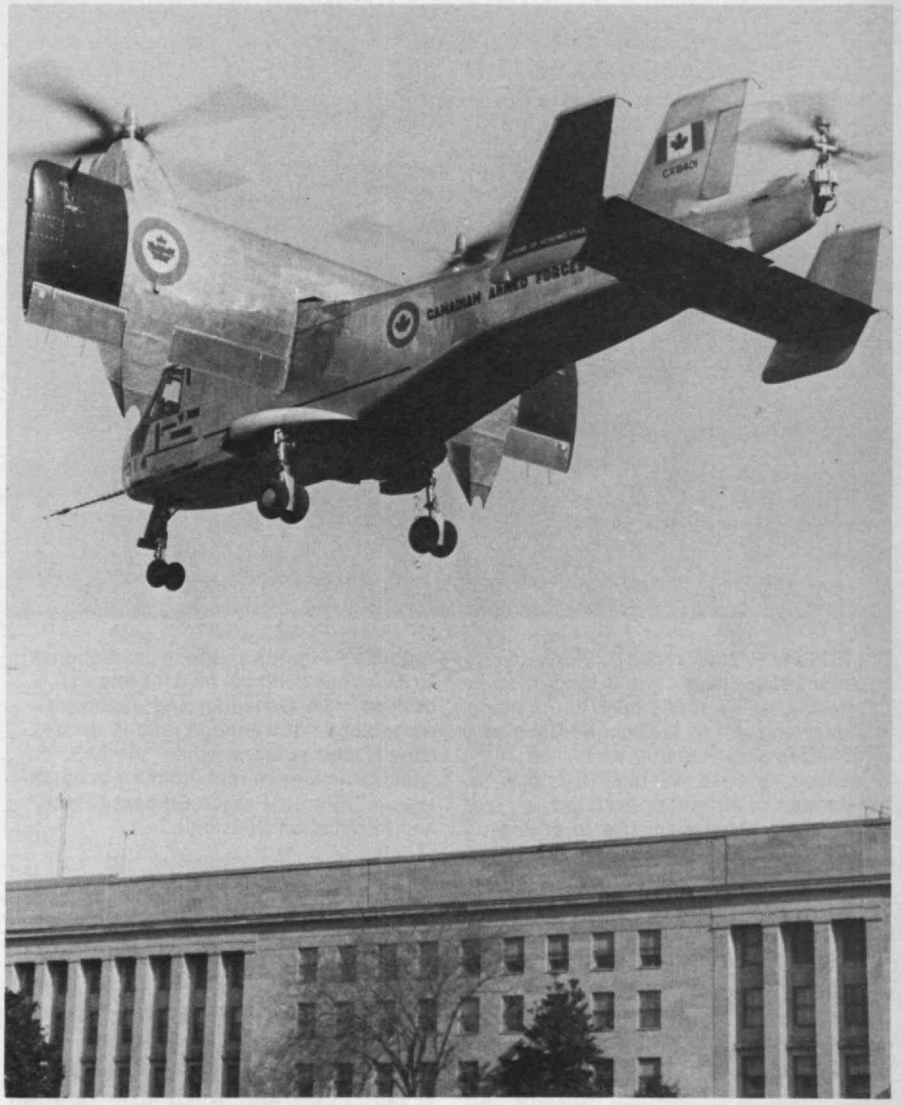
Charles W. Harper is Special Assistant for Interagency Affairs and **Hans Mark** is Director of the National Aeronautics and Space Administration's Ames Research Center, near Mountain View, Calif. Mr. Harper has been with N.A.S.A. since 1941, when he graduated in aeronautical engineering from the University of California (Berkeley); his early assignments included wind tunnel work at the Ames Research Center, and he has served for six years in N.A.S.A. headquarters in Washington, D.C. in the Aeronautical Vehicles Division and Office of Advanced Research and Technology. Mr. Harper was among many contributors to the M.I.T. summer study of short-haul air transportation from which the preceding paper, by Henry Faulkner, is based. Dr. Mark, a physicist and nuclear engineer, has taught at Boston University, M.I.T. (where he received his Ph.D. in 1954), and the University of California in nuclear structure and x-ray astronomy. He has been Director of the Ames Research Center since February, 1969.

There is a strong case for civil transport aircraft which would dispense with the long runways needed by conventional jets. But at present the makings of a transport system based on such aircraft exist only as uncorrelated fragments of technology. Here is a proposal to proceed toward the larger goal in a series of economically sound steps.

operations. Even when these small transports barely reached cruise altitude before beginning descent, they were profitable because the demand for travel was high. Just as the big jets drove the long-range propeller aircraft out of operation, the small jets drove out the short-haul props, because of their much higher public acceptance resulting from speed, comfort, and simply "modernity." The short-haul operators were driven to major re-equipment programs to meet this demand, and a large new aircraft market and travel pattern emerged. By 1970, domestic trips under 500 miles accounted for 75 per cent of all air travel. Jet aircraft used for short haul represented 57 per cent of the fleet in that year, with the smaller twin-jets making up half of the short-haul fleet.

Rapid growth in both long- and short-haul jet traffic created keen competition for airspace and airport runway space. In 1969 delays caused by congestion were sometimes longer on some route segments than the scheduled flight times. Improvements in air traffic control (A.T.C.) techniques, together with a temporary fall-off in travel caused by stagnant business conditions, have relieved this situation for the present, but it is likely that the same problems will soon reappear. And even if improved A.T.C. procedures can hold off congestion problems in the air and within the airport, ground traffic to and from the airport is on the verge of hopeless saturation.

To circumvent both kinds of congestion, major airport expansions and new airport construction have been planned, but the plans have been blocked in one community after another because of the nuisance that aircraft operations could (and in some cases do) impose on local



The Canadair CL-84 tilt-wing turboprop was demonstrated to U.S. Navy observers this February. This V./S.T.O.L. aircraft has provided much of the technical background for a Canadair tilt-wing S.T.O.L. design, the 70-passenger CL-246, which was among those reportedly considered by American Airlines (see following picture caption). The authors note that military and civil requirements for the performance of S.T.O.L. and V.T.O.L. craft tend to differ, but believe they could usefully be combined so as to concentrate available resources.

The Breguet 941, a French military aircraft which can take off and land in 500 ft. and cruise at 250 mile/hr., is being further developed by McDonnell Douglas in an "advanced" version which the U.S. company calls the 188F. It is one of a number of aircraft considered by American Airlines for use in an "interim" S.T.O.L. service. Other aircraft proposed for this purpose in response to American Airlines' evident interest derived from Canadian and Japanese technology. "If a foreign lead is established," the authors write, "the U.S. will this time have real difficulty in catching up." (Photo: French Embassy Press and Information Division.)

residents. Noise and aircraft-generated air pollution thus became national problems.

According to enthusiasts who had been pursuing V./S.T.O.L. technology for many years, the solutions to all these problems would be found in the V./S.T.O.L. transport. It would take off and land like a helicopter and fly like a jet. It would carry crowds of commuters from tops of buildings in cities to urban shopping centers near their homes. It would relieve the compression of population by connecting present metropolitan centers to new cities. It would take vacationers quickly into otherwise almost inaccessible parts of the world. Congestion around major airports would disappear, and a general relief from ground congestion would result.

The scene appeared to be set for the dramatic entrance of V./S.T.O.L., which—it was thought—would not meet the public resistance that had prevented the further expansion of air transportation along conventional lines.

V./S.T.O.L. Past and Present

But when we tried to turn to the 15 or 20 years of V./S.T.O.L. research and technology for a means of short-haul transportation that would gain public acceptance, some serious gaps were found. Many vehicle concepts had been studied and even flown; they showed that an aircraft could be made to go straight up and down, even successfully at times, or take off and land very slowly from small areas. But this did not answer all the questions, and the rest of the answers were hard to find.

Scant attention had been paid to the control of noise, particularly to the reduction of noise to the very low levels that were now being specified. Too little attention had been given to how to organize new airways and terminal procedures that would enable these aircraft to operate with high frequency and regularity without conflicting with the long-haul systems. Too little attention had been paid to the fact that these aircraft would need a cruise speed and efficiency about as high as the existing smaller jets if they were to form a viable system—they were always pictured taking off or landing, never in steady flight.

V./S.T.O.L. aircraft were envisioned carrying masses of commuters to and from work, but the problems of bad-weather operation, air traffic control, and what to do with large amounts of equipment during off-peak hours had been conveniently forgotten. Too little attention had been given to the fact that new and special propulsion systems would be required, designed for frequent starts and stops. Too little practical thought had been given to the regulations and operating constraints that would probably be imposed to ensure safety; and indeed, many of the proposed concepts were so complicated, mechanically and electronically, that it was hard to envision safe, regular, frequent operation at the levels of maintenance which economics would allow.

The new world of slow-take-off aircraft serving short-haul transport will not spring into being in full flower; it will come through a slow, evolutionary process the pace of which will be set by hard-headed bankers demanding that each stage exhibit sound economics before the next is approved.

All this is not to say that these factors had been forgotten; they had been discussed at length, but hard technology to support the speculations was lacking. A particularly common failing, easy to identify, was the pursuit of intriguing technical lines which would clearly not have matched operational requirements even if physically successful.

Of course, the role of V./S.T.O.L. in transportation was the subject of numerous studies. A failing of many of these studies was that they envisioned revolutionary steps—for example, fleets of new aircraft that would fly into metropolitan centers from new cities built in pleasant countrysides. This may happen eventually, but such a scenario does not face the higher probability that this desirable state of affairs will be reached through a slow, evolutionary process. Only recently has it been admitted by the enthusiasts that an ideal V./S.T.O.L. system will not spring into being in full flower but will come in a step-by-step fashion, at a pace set by hard-headed bankers demanding that each stage exhibit sound economics before the next is approved.

This is not to say that the imagined long-range goals are not right or proper—only that they will be reached along a tortuous path, adding elements of V./S.T.O.L. capability to the present system as economics dictate. Realistically, then, we must define a plan that will take advantage of every opportunity to move in the desired direction and must prepare all the technology needed to seize each specific opportunity.

The S.T.O.L. Situation

One likely first step would be to introduce quiet aircraft which have S.T.O.L. capability as well as the speed, range, and payloads of the current smaller short-haul jets. The combination of S.T.O.L. capability with low noise should circumvent many of the congestion and nuisance problems of the current short-haul system and thus make for more effective exploitation of this market. The economic and social benefits of this relatively modest step are perhaps definable with enough certainty to attract financial support. This expansion of system capability can be done in an evolutionary way, not throwing away the system experience we have acquired but building on it. If the great short-haul market shown by many studies really exists, a good S.T.O.L. operation should expose it and provide the courage and incentive to risk developing the more expensive and complicated but more flexible V./S.T.O.L. technology.

The requirements for a S.T.O.L. aircraft system that would start this evolutionary process are fairly evident.

□ *For the aircraft*: short-field operation (1,500 to 2,000 ft.), low noise levels (95 EPNdB. at 500 ft. with a potential for another 10 EPNdB. reduction), high cruise speeds (Mach 0.7 to 0.8 at least), direct operating costs competitive with today's short-haul (2.0 cents per seat-mile), and a design concept that would facilitate the construction of both a 50- to 70-passenger twin-engine, and a 100- to 120-passenger four-engine aircraft from nearly identical engine and airframe technology, so as to capture the whole market with one development. (EPNdB. is a standardized measure of noise loudness corresponding to human perceptions—Effective Perceived Noise in deciBels.)

□ *For the airways*: precise, multiple enroute flight paths and steep, curved terminal approach paths making full use of S.T.O.L. capabilities, to provide the ability to operate from congested airports without conflict with long-haul traffic.

□ *For the major airports*: special S.T.O.L. strips and passenger handling, so that the convenience and time-saving gained in the air are not lost on the ground.

The first market for such a system probably would arise from the need to relieve the air traffic congestion created by present short-haul operations; the greater future market, arising from problems of ground access to the airports, would probably materialize after low-noise, reliable, and safe S.T.O.L. operation had been well enough demonstrated at existing airports to render the idea of community S.T.O.L.-ports palatable to the public. Significant steps toward a workable S.T.O.L. system are being taken by a number of groups in both the public and private sectors, and there are some good reasons for expecting a successful outcome.

It would seem, then, that the way to V./S.T.O.L. through S.T.O.L. can be described, but answers to all the technical questions are not in. Nevertheless they are close enough so that an intensive, short-term, well-directed program can provide them.

The V.T.O.L. Situation

One way to V./S.T.O.L. is to evolve a S.T.O.L. aircraft system from conventional aircraft. Another way could be to give the helicopter enough of the characteristics of an airplane to provide economically viable V.T.O.L. transport. The heli-

copter has proved its worth for many specialized applications but has failed to become a paying element in the transportation system. The two principal reasons seem to be that 75- to 150-mile stage lengths would be needed to attract support for the valuable but costly short-leg metropolis-hopping, while the useful range of a pure rotor-craft does not stretch that far; and that shoving a lifting rotor sideways through the air at any speed is not conducive to long life of parts and low maintenance costs.

To move from this starting point toward the true V./S.T.O.L. transport system with dependability adequate to assure economic success involves meeting three requirements:

☐ A machine is needed that keeps the existing hover and low-speed V.T.O.L. capabilities of the helicopter (perhaps with reduced noise), cruises at 300 to 350 kn., and has cruise efficiencies giving 75- to 150-mi. stage lengths with useful payload, with greatly reduced noise and maintenance-generating vibration.

☐ Very precise guidance and navigation systems—even more so than for S.T.O.L.—are required, to assure regularity of operation under poor weather conditions in obstacle-filled areas.

☐ Separate helicopter landing sites must be developed to avoid the ground congestion problem now faced by major airports. Unlike S.T.O.L., the helicopter—partly because it has not become a national nuisance as has the conventional jet—has not (yet) met with public resistance to take-off and landing operations, and many operating sites are available.

The technology required to meet the first two requirements is not so readily available as in the S.T.O.L. situation. Attempts to provide rotor-craft with the needed higher speed and longer range have introduced mechanical and electronic complications which raise concerns regarding safety and maintenance—which, in turn, could play havoc with the system economics. The levels of precision required of guidance and navigation to operate dependably in inclement weather appear to be beyond anything yet demonstrated satisfactorily in practice. Research and development is under way on these problems, but the systems requirements are not so well defined that the best course is readily discernible. The danger is that the effort to develop V.T.O.L. aircraft will be spread thin and will follow many lines of vehicle development which even if successful would not necessarily meet the system requirements.

It will be absolutely necessary to put aside this tendency to follow out all technical approaches, and to concentrate instead on only those that could meet requirements. And yet establishing the requirements that would guide the technical development of a V.T.O.L. system along proper lines is not easy. The S.T.O.L. enthusiast can point with some assurance to the potential market that would emerge if the current short-haul jets had S.T.O.L. capability, on the basis of the success of the existing short-haul systems. The proponent of V.T.O.L. can cite no analogous success story; V.T.O.L. systems have been successful only in specialized operations—military, for example—none of which are of much help in crystallizing the case for investment in a major civil system. Unless this uncertainty can be resolved, it may be that new V.T.O.L. developments will come only in the form of responses to defense needs. This would allow the commercial market to be tested with reduced civil expenditure, but only in an effective way if some thought were given to this during the military development. If this is likely to be the pattern, it obviously becomes important to consider civil requirements during the development of V.T.O.L. vehicles for defense purposes.

The V./S.T.O.L. Situation

If either a S.T.O.L. or a V.T.O.L. rotor-craft transport system, or both, can be brought into being in such a way as to remove some of the constraints now hampering the growth of air transport, serious attention can then be given to true V./S.T.O.L. transport systems as a later replacement for S.T.O.L. and V.T.O.L. craft. This view implies that the true V./S.T.O.L. system will be the second generation from where we are today. This opinion may offend the technical enthusiasts who assert that a V./S.T.O.L. vehicle can be built now, but the question, to repeat, is not whether a V./S.T.O.L. transport vehicle can be built, but whether a V./S.T.O.L. system can be built that meets all transportation system requirements, including economics, while being wholly acceptable to communities becoming ever more conscious of their environment. However ideal it might appear to by-pass the evolutionary steps we have described, it seems hardly reasonable to expect the very major investment that would be required, at very high risk, to assembly a total V./S.T.O.L. transportation system without the example of some prior, closely related, very successful operation.

It is not difficult to conclude that V./S.T.O.L. transportation even-

If V.T.O.L. aircraft are to succeed, it will be absolutely necessary to put aside the tendency to follow out all technical approaches. Yet is is hard to determine the technical and system requirements on the fulfillment of which research and development must focus.

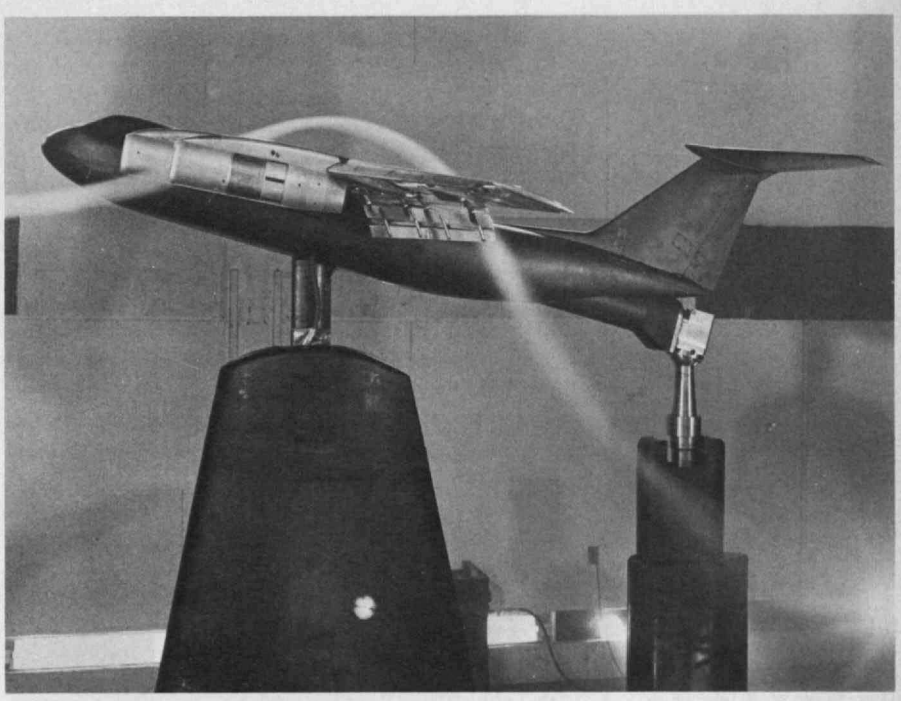
tually will play an important role, and that the technology must be pushed to be ready for the day it is needed. And it can also be concluded, as argued here, that V./S.T.O.L. systems will evolve from S.T.O.L. and V.T.O.L. systems, and that the technology must push in a direction such as to support this evolutionary process if real progress is to be made. We should not repeat the mistake of assuming that when a new kind of vehicle is needed all past experiences and operations will be thrown away in favor of a new start. Thus, experience with S.T.O.L. and V.T.O.L. must be used to give firm direction to the technical efforts on V./S.T.O.L.

The Military Role

The discussion to this point has been aimed deliberately at the commercial transport problem, without consideration of military interests. Our reason is that we consider it more difficult to meet civil than military requirements in air transportation. It would appear, however, that military requirements for S.T.O.L. transportation and advanced V.T.O.L. rotorcraft are crystallizing.

It thus becomes increasingly probable that the development of such vehicles will be initiated by defense needs. Because some of the difficult civil constraints (particularly noise, traveler acceptance, and—perhaps—economics) may be relaxed in the military case or replaced by other constraints peculiar to the military, it is possible that military development could evolve along lines contributing little to future civil development.

To allow this to occur would be a serious mistake, for several reasons. Separating military and civilian development would force us to find support for twice as many lines of technical activity. The military would be in a much stronger position if a civil fleet having much in common with the military units were in existence to supplement them. Both military and civil users would have a better aircraft at lower unit cost if a single basic vehicle supplied the combined market. And finally, technical development along fewer lines would make for fuller exploitation of the chosen approaches.



In this wind-tunnel experiment at Lockheed-Georgia, downward deflection of air by a "multi-slotted flap" lift-augmenting arrangement is revealed by a smoke tracer. (The fuselage of the model is basically that of the C-130.) In December N.A.S.A. awarded a $1.5 million contract for a S.T.O.L. design study to a group comprising Lockheed, Bell Aerospace, N.-A. Rockwell and Cornell Aero Laboratories.

Is V./S.T.O.L. Worth the Effort?

Perhaps enough has been said to indicate that advanced rotorcraft V.T.O.L. systems, S.T.O.L. systems, and ultimately V./S.T.O.L. systems will not come easily or without considerable coordinated effort on the part of many groups. (The technical problems involved are reviewed in detail in the accompanying article by Henry Faulkner.) We have highlighted some of the pressures for and against development. In this light it is pertinent to ask again, "Is V./S.T.O.L. worth all this effort?"

The answers fall into two groups, those that can be developed from existing facts and those that derive from speculation. In assessing the merits of pursuing V./S.T.O.L. these

Sikorsky Aircraft last year joined with Pan American World Airways in three days of demonstration flights between six major cities "to prove the feasibility of intercity helicopter operations in the Northeast Corridor." Publicity laid much stress on the fact that the helicopter—the Marine Corps' 53-D, also known as the S-65—achieved shorter journey times than conventional jets. However, a full-scale civil V.T.O.L. transportation service, the authors observe, would require "very precise guidance and navigation systems—even more so than for S.T.O.L.—to assure regularity of operation under poor weather conditions in obstacle-filled areas."

two must be kept well separated, and they will be treated that way here.

The facts are that short-haul air transportation (less than 500 miles and more than 50 to 100 miles) grew by a factor of three from 1961 to 1968. Because smaller aircraft are used for this purpose, the number of operations at the major airports increased rapidly. Some airports became operationally limited by congestion, and many are headed that way. Public demands and competition, as we have seen, forced smaller short-haul carriers to re-equip with small jets, and many smaller fields became marginal or unusable. It was predicted from these circumstances that, if no relief were found, airport congestion would cause a gradual demise of short-haul air transport.

Solutions for the problem were sought in several ways. The Air Traffic Control Advisory Committee (A.T.C.A.C.), sponsored by the Department of Transportation and the Federal Aviation Administration, identified steps that would increase existing airport capacity through progressive modifications to airports and air traffic control techniques. Many communities gave consideration—vociferously opposed by the public—to new airports, in order to separate long- and short-haul traffic. In part, this step stemmed from the recognition that raising the aircraft capacity of existing airports would only create intolerable ground transport congestion.

Throughout these activities, it was increasingly realized that V./S.T.O.L. or even just S.T.O.L. capabilities added to the current capabilities of short-haul aircraft would provide a major relief from the difficulties that the short-haul systems were facing—that

Is V./S.T.O.L. worth the effort? To answer that question, we must separate data from existing facts and data deriving from speculation. Having done this, the authors conclude that such aircraft have a role in meeting real transport requirements, and that their development should now be pursued. How?

V./S.T.O.L. systems would be required if the increasingly important short-haul air systems were to remain viable.

Additional pressure for some form of S.T.O.L., V.T.O.L., or V./S.T.O.L., development comes from the weakening economic position of the aerospace industry. A new and major market is needed to replace the slowdown in space activity, the suspension of the S.S.T. program, the reduction of military programs, and the saturation of the conventional jet transport market. Because the aerospace industry has become one of the largest contributors to the national economy, this concern is of national importance. Counting only the market clearly defined by the expected short-haul traffic demand, some estimates show sales up to $2 billion a year within ten years after first availability of new S.T.O.L. equipment. It is to be expected that, given this new operational capability, short-haul would develop new and important markets just as the conventional jets did.

It is worth commenting that the nation cannot expect to exploit this market at its leisure. Every nation with an aircraft industry is competing in it. Two of the earliest successful conventional short-haul jets were the British B.A.C.-111 and the French *Caravelle*. The American industry was able eventually to gain the greater share of that market because of its closely related experience in building most of the world's long-range jets. The foreign industry is turning its attention increasingly to S.T.O.L., V.T.O.L., and V./S.T.O.L. short-range aircraft and holds a large part of the existing experience with such aircraft, in both research and operation. If a foreign lead is established, the U.S. will this time have real difficulty in catching up.

Forecasting V./S.T.O.L. Economics

Speculations regarding the eventual market for short-haul V./S.T.O.L. aircraft cover a wide range. Three lines of reasoning frequently advanced are worthy of mention. First, the growing movement toward decentralization of population within the U.S., and particularly the proposed nearly self-sufficient new cities, should provide a major short-haul travel market in which continued financial, cultural, and political contacts with metropolitan centers will be required on a frequent but not commuter basis. Second, there is the growing leisure time available to many people who want to enjoy inaccessible wilderness areas without despoiling them through massive ground access systems. Third, transportation is recognized world-wide as the major ingredient in the economic growth of presently underdeveloped areas. In several such areas, successful short-haul air transportation could satisfy primary requirements while obviating the need for extensive major ground-based networks.

The validity of these speculations cannot be proved (if it could they would not be speculations!), but they hold the promise of enlarging a reasonably attractive market into one of enormous potential for the right eventual system.

The attractiveness of a short-haul system that covers the 50- to 500- or 700-mile range is comparatively easy to recognize. But a positive position on air transport for the range below 100 miles is much more difficult to reach. A tremendous travel market exists for this short range, but the competition from existing ground transportation is very intense. The passenger-seat-mileage required in metropolitan areas is so high that mass air transport seems impractical; but even if restricted to a small percentage of people with special requirements, the absolute potential demand is high. (These speculations will be the subject of an article by Professor Rene H. Miller of M.I.T. in the next issue of the *Review.*)

A great many attempts have been made to test and assess this short-haul market using helicopters derived from military developments or small S.T.O.L. aircraft. Only a few have been more than marginally successful, and these usually centered around special cases—most notably, local transport to major airports where ground congestion became intolerable. As noted earlier, inability to provide regular reliable service seems to prevent a major expansion in even these specially favorable circumstances. So, on the basis of past experience, the case for the very-short-haul (less than 100 miles) air transport seems to the present authors not very strong.

However, one can put it another way: Several very-short-haul systems have almost succeeded economically, even though they were using equipment designed fundamentally for military objectives, were forced to adopt navigation and guidance systems designed for other purposes, and had only partial freedom to exploit the real capabilities of their vehicles enroute and at major air terminals. It would seem logical to expect that, with the introduction of S.T.O.L. equipment to meet inter-urban or inter-city requirements, the complementary time-saving V.T.O.L. intra-urban or intra-city service would assume added sig-

nificance. While the justification for proceeding rapidly with civil development may not be so clear in the very-short-haul case, the potential value is high enough to merit serious attention to defining clearly the requirements and developing the best technology to meet them. Military interest in this capability is also growing, and an almost ideal opportunity exists to couple these interests and requirements at an early stage for mutual guidance and support.

The question of the true V./S.T.O.L. system that would combine the capabilities and meet the requirements of both the S.T.O.L. and V.T.O.L. systems is much more difficult to answer. Such speculations as exist would lead to the conclusion that if both requirements are to be met in a single system, its technical elements will be substantially different from, and more sophisticated than, anything yet developed; and therefore its development and implementation costs will still be too high. This investment will probably not be supportable until the more evolutionary, less costly S.T.O.L. and V.T.O.L. systems have proved their worth. Fortunately, it does not appear that this strategic delay would result in much lost effort. The critical elements now lacking—the aircraft technology, the S.T.O.L.-ports, the V.T.O.L.-ports, and the precision A.T.C. system and operating procedures that must accompany them—should form a satisfactory basis for a true V./S.T.O.L. system. To assure evolutionary continuity, however, V./S.T.O.L. system development must be coupled very closely to S.T.O.L. and V.T.O.L. system requirements and operational experience.

The Implementation Problem

We have attempted to develop the argument that S.T.O.L., V.T.O.L., and V./S.T.O.L. can play a useful and important role in meeting real transportation requirements, both civil and military, and that therefore their development should be pursued. The obvious question is, "How?" It is difficult to conceive that S.T.O.L., V.T.O.L., or V./S.T.O.L. air transport systems would stand high enough among national priorities, even among civil transportation needs alone, to receive total federal developmental support. The priorities of keeping the long-haul air system operational and of developing local mass transit systems, for example, would undoubtedly be higher. Among all the other kinds of national tasks, these in turn might well lie below such problems such as environmental control.

It is almost as difficult to conceive that military developments can again play the basic role which they had in the development of the long-range jet transport, where the basic work on propulsion systems and airframes evolved directly from military applications. The military have many high-priority development needs that would contribute little or nothing to V./S.T.O.L., and the additional cost of adapting their V./S.T.O.L. interests to meet civil requirements will probably be high enough to require some special effort.

Nevertheless, every indication is that S.T.O.L., V.T.O.L., and V./S.T.O.L. will remain attractive enough so that both government and private industry will devote at least some resources to them, until they either succeed in developing viable systems or prove that such systems are illusory. The key task is to channel those limited resources toward a reasonable decision point at the earliest date.

When the reasons we put forth earlier for the failure to achieve satisfactory S.T.O.L., V.T.O.L., or V./S.T.O.L. systems hitherto are reexamined, it could be concluded that, with only minor expenditure of resources, some major steps forward, such as the following, can soon be taken:

☐ Establishment of an agreed set of reasonable civil and military operational requirements which, if met, would get a system started. This involves little more than an unemotional assessment of the many studies already made.

☐ Establishment and clarification of the whole regulatory framework within which these systems would have to work; included are aircraft certification standards, air traffic control procedures, and local regulations relating to aircraft. In lieu of experience, a first but acceptable attempt at this will probably have to be based upon various forms of simulation (of aircraft and systems).

☐ Systematic weeding out of technologies that cannot meet all the agreed-to requirements (even where all but one of them are perfectly satisfied). This recommendation means deferment of all those promising technologies that only need "one more breakthrough" to be the perfect answer—"the best is the deadly enemy of the better." The point here is to focus development so that the competition is between details along common lines rather than in widely different directions, in order that available resources will be far more effectively employed. Here, too, the actual cost of this measure is low, although the price in pride of ownership may be high.

☐ Organization of many more-or-less scattered activities into a related plan pointed at meeting the requirements, once they are established, as quickly as possible. Interest in S.T.O.L., V.T.O.L., and V./S.T.O.L. is widespread, and new activities are constantly springing up, usually in support of some narrow objective, often duplicating or directly conflicting with other activities. It ought to be possible for any group developing an interest in S.T.O.L., V.T.O.L., or V./S.T.O.L. to turn to a central point and then choose whether to join a common activity or strike out on its own. None of this organization should be costly.

☐ Identification of the missing technical elements (in relation to some central plan) and the resources and means needed to bring them into existence. This may be costly. (Mr. Faulkner, in the previous article, suggests the scope of this matter and gives an optimistic view of our prospects.)

In short, the approach suggested here requires identifying probable losers early in the race and postponing attractive but expensive technical alternatives until the success of an adequate, cheaper solution has verified the worth of the whole S.T.O.L./V.T.O.L. principle.

David Gordon Wilson and
Ora E. Smith
Department of Mechanical
Engineering
M.I.T.

How to Reclaim Goods from Wastes

Grandma used to save the wrapping paper from Christmas to Christmas, and some of us still bundle our newspapers for church or Boy Scout collections. Now a few of us are beginning to sort and save tin cans and nonreturnable bottles. But the fact is that we have so mechanized processes of production that the man-hours needed to supply our consumer goods are far fewer now than in the past. It probably requires more man-seconds of labor for a householder to bundle up the week's newspapers, and for these newspapers to be handled, baled, transported, handled again, and repulped than the paper industry consumes in cutting, debarking, transporting, chipping, and pulping trees to make fresh newsprint.

Distorted economics and political complications have led us to mechanize the production of newsprint from trees without similarly mechanizing the collection and handling of so-called "secondary fibers."

We have apparently assumed inexhaustible resources on the one hand and, on the other, large tracts where waste materials could be dumped. Now, suddenly, we are awakened by the discovery that we are deluding ourselves—that our policy of consume-and-discard is in fact wasteful and destructive. We are destroying irreplaceable natural resources at both ends of the process in which we use them.

Thus the need to recycle our resources is apparent. Many of our man-made materials—most plastics, for instance—can be reused only with difficulty, and in such cases we must learn to make instead new materials which can be recycled. But for a substantial proportion of our domestic trash there are well-established processes, and industries based on them, which can and do reclaim large quantities of materials —paper, glass, metals, and textiles are some of these—and which could absorb greater quantities were they available. Where progress is required is in the management of the material between the home and business to the reprocessor, and this is our concern here.

We assume that neither householders nor businesses will be willing or perhaps even able to go back to separating one kind of trash from another. If they were, the task of collection would become enormously more complicated but that of processing much simpler. Separating mixed trash in a central treatment plant after it has been collected requires fewer changes in existing patterns. We accept the penalty that this mixing reduces the value of some components, principally paper.

For many years, some separation of valuable components from mixed trash has officially or unofficially taken place at incinerators and dumps. Some mechanization has occurred: often an incinerator is fed by conveyor belt. "Picking stations" with hoppers going down to baling presses are arranged along the belt so that one man removes clean newspapers, another corrugated cardboard, and so on. At some point an "overband" magnet removes ferrous components. The largest operation of this type was found at the Lone Star Organics plant of the Metropolitan Waste Conversion Corp. in Houston, Texas. Central processing plants, however, are capable of much more mechanization, separation, and economic salvaging of resources. This paper records some of the possibilities which modern technology suggests.

The Dollars and Cents of Reclamation

One way of evaluating the economics of various methods of reclamation is to determine both the cost of separating each component and the price which it, in various quantities, might bring. The wide fluctuations in the price obtained for waste materials from year to year make this an uncertain approach.

A more conservative approach is to consider the avoidance of the cost of alternative methods of waste treatment as the principal benefit, and to disregard any income from reclaimed materials. The minimum benefit of separating is, therefore, that disposal of the reclaimed materials is free. Neglected in each calculation is the fact that the remaining unsalvaged material will be reduced in volume and thus easier to dispose of. The second method seems sufficiently conservative to predict that, if a reclamation plant can prove to be economically advantageous to a community in these circumstances, in practice and at most periods the profitability will be high.

The two most-used methods of treating solid municipal waste are dumping and incineration. The costs per ton for treatment, aside from

David Wilson has taught at M.I.T. for the last six years, working in such areas as solid waste disposal, dual-mode transportation, and turbomachinery. He has taught at M.I.T., Harvard, and the Nigerian College of Science and Technology. Two books he has edited are due for publication this year: *Treatment and Management of Urban Solid Waste* and the *Solid Waste Management Handbook.* **Ora Smith** received his S.B. and M. Mech.E. from M.I.T. and worked with Dr. Wilson as he studied for the latter degree.

collection, vary from about $1.50 to over $20. A rural community having within its borders spoiled land of no economic or ecological value until it is filled might pay $1.50; that sum would cover fencing, supervision, and bulldozing. It seems probable—and certainly desirable—that open dumps will be outlawed soon in most communities, and then the costs for some form of sanitary landfill, about $3 per ton for small operators, will form the lower limit.

Paying up to $20 are those large cities which have used up all the dumping space within their borders; whose neighbors are either outlawing, or charging a high price for, dumping in their territories; and which therefore install incinerators to reduce the mass of material to be dumped to 10 to 20 per cent of the initial amount. Incineration costs vary from $5 per ton for very large, well-run plants to over $20 per ton for small, mismanaged plants. These figures are likely to increase rather than decrease as air-pollution-control equipment becomes better and more expensive and as labor costs rise.

At some point in this cost range a separation-reclamation plant should become competitive even without offsetting its expenses with any income from the salvaged materials. A safe conclusion should be that in areas where the disposal charges are about $10 per ton and where the waste flow is 500 tons per day—conditions which are found in many large cities—a sorting and reclamation plant should be profitable even if the market for "secondary" materials is uncertain. In a higher-disposal-cost area, and with greater automation, profitability should be assured.

Present practice suggests that these predictions, which are conservative because they assume that the separated materials will be taken away without being paid for, are probably too pessimistic. The MetroWaste plant which served Houston failed to break even by $1 to $2 per ton; but Houston paid MetroWaste only about $4.25 per ton. Sanitary Refuse Collectors, Ltd., of Montreal was reported as making a profit of 57 cents per ton from salvage by traditional manual "picking" procedures from a conveyor belt feeding a grinder. This company closed operations only when the municipality permitted a low-cost landfill to open in the area.

If current prices could be used for the value of reclaimed paper, cans, and bottles, a high-capital-cost reclamation plant could be justified in many areas where the cost of alternatives is high. A reclamation plant needs no air-pollution-control equipment and no stack, and—even assuming very sophisticated sorting equipment—its capital cost should be less than that of an incinerator to deal with the same volume of waste.

The importance of reclaiming a high proportion of the useful materials in waste received by a plant should be emphasized. To justify installing equipment to handle 500 tons of refuse daily, a major portion of this flow must be diverted: most of it must not simply pass out of the plant as useless residue.

A number of ingenious machines offer their services.

The Machines that We Might Use

Machine sorting has at least two distinct parts, coding and switching. It is often suggested that all materials should be coded during manufacture with a tracer to help sort them for reclamation, but no workable system has been proposed. Accordingly, we must continue to try vigorously to develop equipment to sort mixed trash into its valuable and valueless constituents.

Some highly sophisticated machines have been developed for particular purposes, such as the sorting of mining ores, seeds for agriculture, mail, and airline luggage. The inhomogeneity of mixed refuse makes the task of sorting—or even just of coding it—far more difficult than for such comparatively uniform feeds as ores, where the choice to be made is usually binary: is the ore high- or low-grade? Is the material coal or shale?

Consider then a typical item of refuse: a beer can. It may have a paper label or be printed, it may be all aluminum or have a steel body and aluminum ends, and it may be half full of left-over beer or of rain. A strong magnet may decide that this item is ferrous. A meter sensing its surface characteristics only may code it as paper. And a sensor measuring attenuation of radiation passing through the can will probably decide that something having so high a content of water must be fruit. All this is supposing that the can could be measured alone. It may well be wrapped in a paper or plastic bag or in a nylon stocking, or have some butter paper stuck to it.

Two responses are possible to problems of this type. One is to use several sensors, or one highly sophisticated sensor, which will measure something besides just surface or just bulk properties and will reject any item whose response suggests inhomogeneity. There are probably enough homogeneous items—newspapers, magazines, telephone books, bottles, cans—in municipal refuse

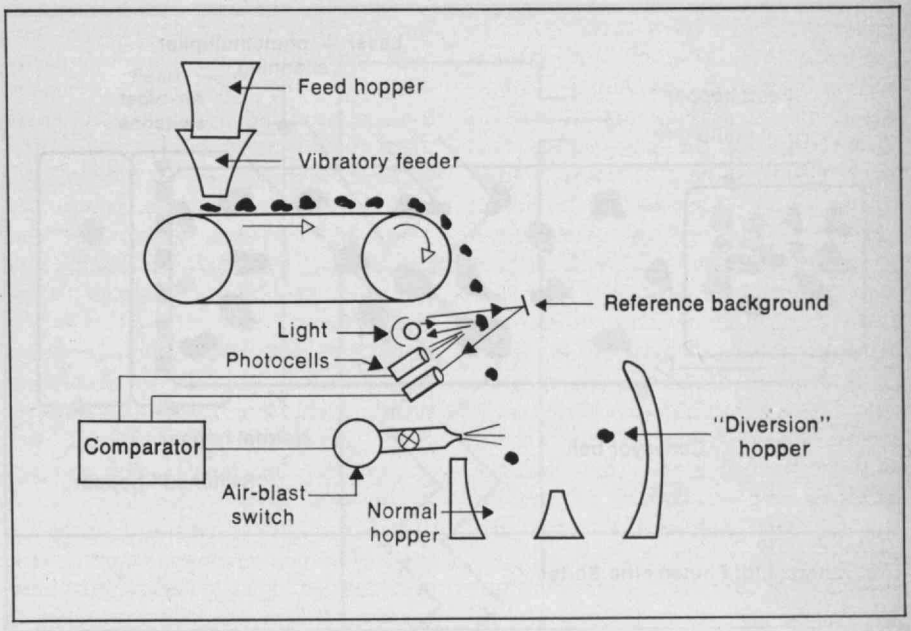
for this response to be reasonable and promising. The second response is to grind everything so finely that the majority of the particles are individually homogenous. The particles can then be treated individually or in bulk.

Whether the refuse is ground or merely separated into individual items, and whether the items or particles are treated individually or in bulk, sensing and switching can be effected in two ways. One is to make successive binary choices until the sorted products of several branches will be sufficiently pure to realize their full market value. (Contaminated materials—paper with plastics, iron with copper, glass with aluminum, cotton textiles with synthetics—fetch a low price if they sell at all.)

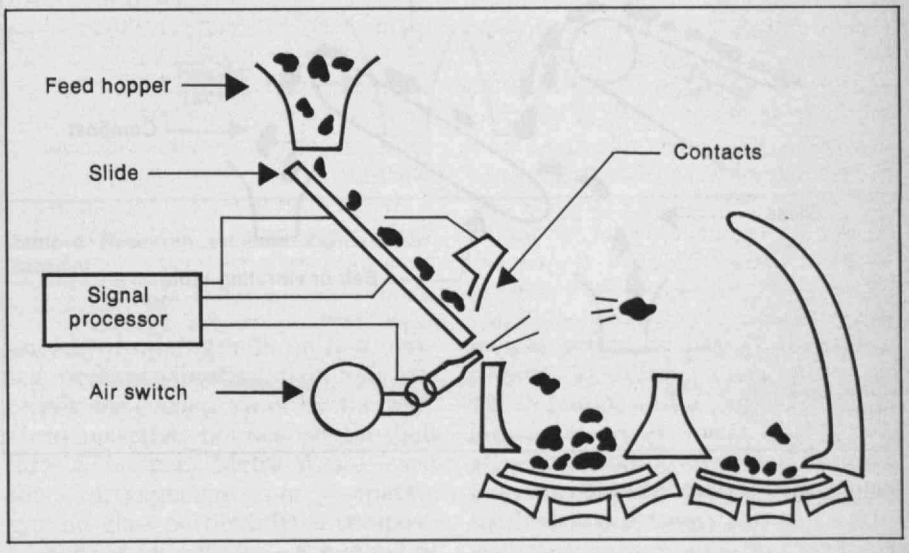
A number of schemes involving binary branched sorters are already available. Among them are these:

☐ *Magnetic coding and sorting*—An "overband" magnetic sorter is always part of a reclamation or compost plant; often it surveys the feed to an incinerator or the ash discharge (where uncontaminated material is obtained at the expense of some oxidation and fusing). It is usually the only available machinery for automatic coding and sorting (in this process, the same operation).

☐ *Color coding and air switching*—A machine has been developed by the Sortex Co. of North America to sort ore by color. The U.S. Bureau of Mines uses it to sort glass fragments into flint glass and colored glass, and a series of such machines could sort the three principal colors of bottle glass (green, amber, and flint). Glass pieces of roughly uniform size (obtained by initial screening) are fed from a hopper to a vibrating table and thence to a grooved belt

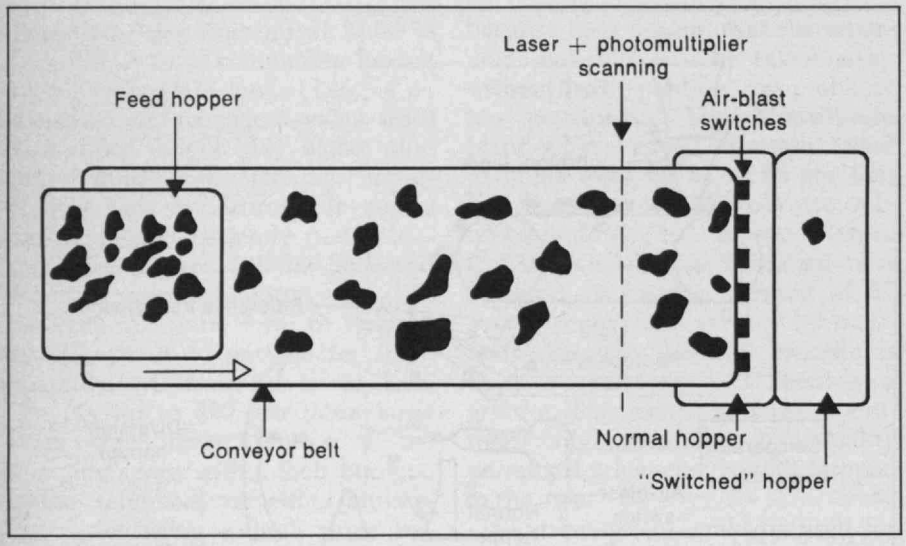


Sortex Co. Color Sorter

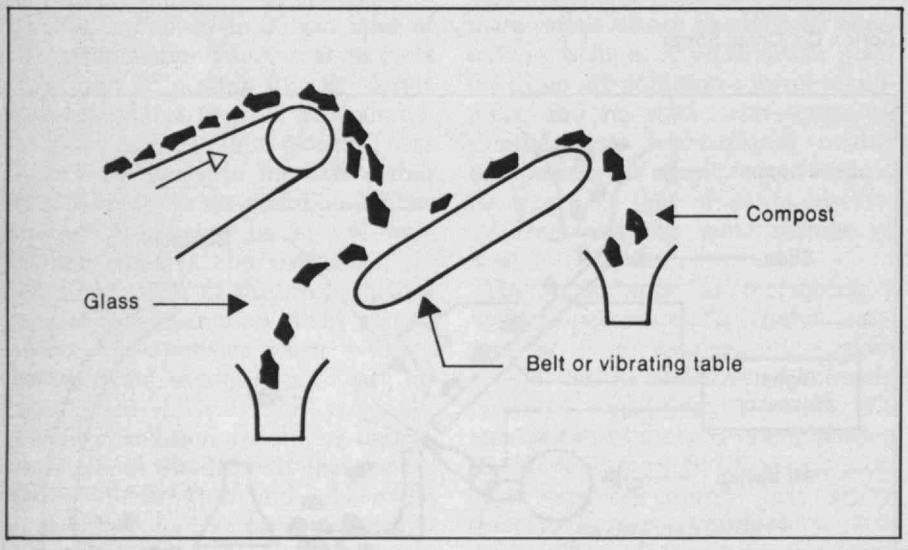


Ore Sorters, Ltd. Conductivity Sorter

As we sense more clearly the finite limits of our natural resources, the need for waste reclamation becomes ever more obvious and the incentives greater. Alternative technologies abound.



Ore Sorters, Ltd. Photometric Sorter



MetroWaste's Bounce Separator

moving at 5 to 10 ft./sec. As the pieces fall from the end of the belt, each one is sensed by three photocells, which compare the color of the glass to the color of a reference background, and the smaller fraction, colored or uncolored, is diverted by rapid-acting air blasts to a separate hopper.

☐ *Conductivity coding and air switching*—Instruments which sense the change of electric field strength when a conductor is moved through the field can, as with mine detectors, discriminate between metals and nonmetals. So far as is known, such instruments have not been used in refuse-reclamation plants for two reasons. They code only; the operation would still need sorting and switching mechanisms. Then, too, mixed nonferrous metals are of little value; means to separate copper from brass from aluminum would also still be needed. But we may now have that capability.

The ore-machinery industry has developed sophisticated automatic machines that sort by direct measurement of conductivity. Ore Sorters, Ltd., of Canada produces a machine in which the ore falls down a 48-in. angled slide. One or more of a series of electrodes carrying a steady potential with respect to the grounded slide make contact with each particle, and the current through the particle enables it to be coded as "high" or "low" conductivity. Air blasts divert either the high- or low-conductivity pieces as they fall off the slide, whichever is in the lower proportion.

☐ *Photometric and radiometric coding and air switching*—Ore Sorters, Ltd., has also built machines which sort by surface reflectance of a scanning laser spot and by radioactive properties. The photometric unit may be useful in sorting mixed refuse, and perhaps trials should be made. A random-feed stream is distributed on a horizontally moving conveyor belt and is scanned by a laser spot reflected from a rotating mirror. A photomultiplier measures the characteristics of the reflected light, and an analyzer determines whether or not appropriate air jets should be actuated to divert each piece.

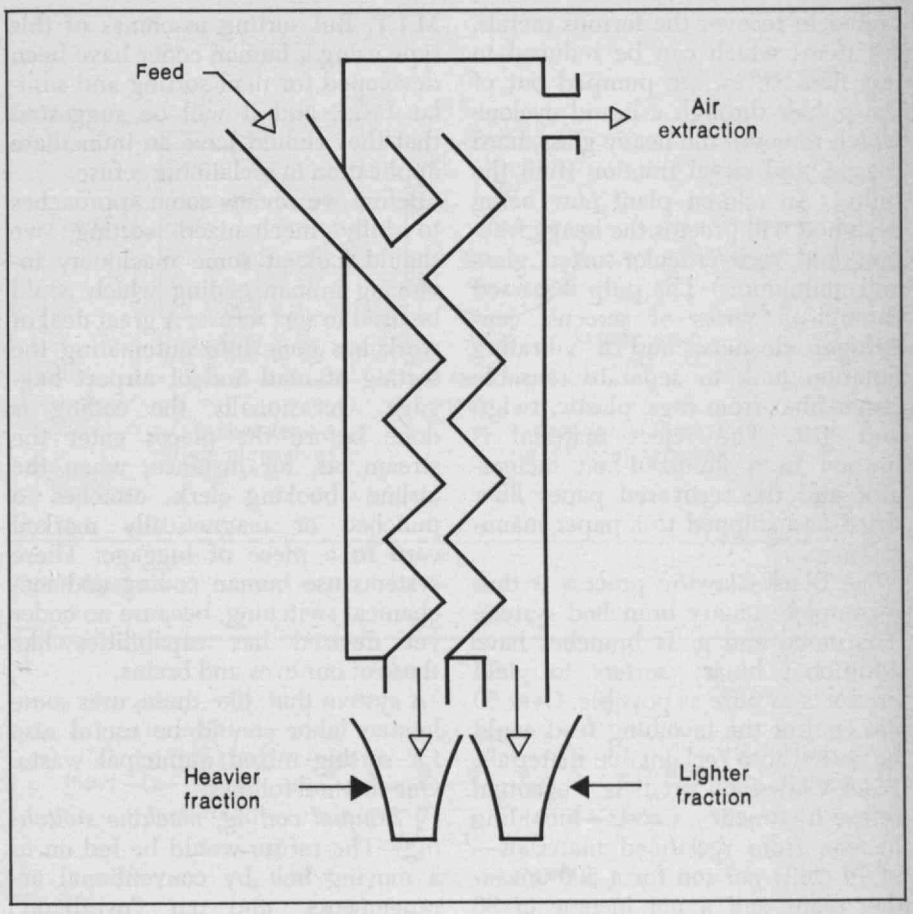
☐ *X-ray-attenuation coding and mechanical switching*—The agriculture and food industry has highly developed coding and sorting machinery. A machine conceived by a Scottish farmer for separating potatoes from stones and dirt uses X-rays for coding. Unlike the two belt sorters just described, however, its switching is by movable fingers rather than by air blast.

☐ *Sorting by density and drag*—A machine developed principally to sort food beans has been applied by Stanford Research Institute (S.R.I.) to the separation of mixed waste. The so-called air classifier consists of a zig-zag duct running vertically. Air is drawn off from the top and the mixed material is fed into the duct at an intermediate point. Pieces with a combination of low density and high drag are entrained into the rising air stream; heavier or lower-drag pieces descend. S.R.I. claims it will sort economically components that vary in density by only a few per cent—obviously a useful machine. This type of machine requires the input to be pulverized, dried, and screened so that any one classifier is fed with pieces varying in size by only a small degree. A wide range of particle shapes put into the air stream will reduce the level of performance somewhat.

☐ *Sorting by froth flotation*—The U.S. Bureau of Mines is recovering metals from incinerator residue by an ore-beneficiation process. This is a branched binary scheme involving successive grinding, size segregation by screening, and separation by surface properties in froth flotation. If the projected economics are accurate, this process also could be significant.

☐ *Sorting by "bounce"*—Hard materials are often separated from soft ones by dropping both on to a moving, perhaps vibrating, belt. Soft materials are carried away by the belt. Hard materials bounce off the belt into a hopper. Metro-Waste used this arrangement to separate ground-glass particles from compost.

☐ *Sorting by pulping*—A method of separation which has reached a stage between pilot and full-scale operation is the Black-Clawson Company's Hydropulping / Fiberclaim process. (The company makes paper-making machinery.) All municipal refuse is passed through a slightly modified paper pulper, in which pumps and a toothed impeller induce a strong vortex that forces all material into the region between the rotating impeller teeth and toothed stator rings: the soft materials are pulped and the hard objects are shattered or torn apart. Large hard items, such as balled-up cans, hard rubber, and solid pieces of metal drop out through a counterflow chute; they are removed by a conveyor and are magnetically sep-



Stanford Research Institute Zig-Zag Air Classifier

arated to recover the ferrous metals. All items which can be reduced to less than ⅝ in. are pumped out of the pulper through a liquid cyclone which removes the heavy glass, hard plastic, and metal fraction from the pulp. (An add-on plant now being designed will process the heavy fraction and recover color-sorted glass and aluminum.) The pulp is passed through a series of screens, centrifugal cleaners, and a vibrating flotation tank to separate reusable paper fiber from rags, plastic, twigs, and grit. The reject material is burned in a fluidized-bed incinerator and the recovered paper fiber dried and shipped to a paper manufacturer.

The Black-Clawson process is thus a complete binary branched system. The metal and glass branches have additional binary sorters to yield products as pure as possible. Over 50 per cent of the incoming feed could be sorted into reclaimable materials. Black-Clawson predicts eventual refuse-treatment costs—including income from reclaimed materials—of 70 cents per ton for a 500-tons-a-day plant and a net income of 90 cents per ton if the volume is 1,000 tons per day. If these projections can be borne out in practice the whole solid-waste picture would be transformed, and steady markets for secondary pulp, glass cullet, and cans would need to be assured. However, the company currently quotes costs of $10 per ton. At present, only 15-25 per cent of the input of this system installed in Franklin, Ohio, is recovered.

Sorting Several Things at Once

The principal alternative approach, the multiple-choice series system, is, so far as we know, being pursued as a fully mechanized system only at M.I.T. But sorting machines of this type using a human coder have been developed for mail sorting and similar tasks, and it will be suggested that they should have an immediate application in reclaiming refuse.

Before we review some approaches to fully mechanized sorting, we should look at some machinery involving human coding which could be used to sort refuse. A great deal of work has gone into automating the sorting of mail and of airport baggage. Occasionally the coding is done before the pieces enter the stream, as, for instance, when the airline booking clerk attaches a punched or magnetically marked card to a piece of luggage. These systems use human coding and mechanical switching, because no coder yet devised has capabilities like those of our eyes and brains.

A system that, like these, uses some human labor should be useful also for sorting mixed municipal waste. One method follows.

☐ *Manual coding, machine switching*—The refuse would be fed on to a moving belt by conventional arrangements, and an "overband" magnet would remove ferrous material for baling. A vibrating sieve would then allow all pieces smaller than, say, a quart soda bottle to drop away for bulk treatment. The remaining large items would be fed to a fast-moving belt so that each is isolated on the belt. This belt would pass a human coder with a set of buttons, one for each component of refuse to be sorted. By pressing an appropriate button as each piece of refuse appeared, he would code a magnetic "stripe" on the underside of the belt or on a magnetic tape geared to the belt. If the code indicated "glass"—or even "green glass"—the coding would later actuate the appropriate diverter to sweep the glass into a hopper. Most likely the glass would be ground; or if it were financially rewarding, whole bottles might be separated for return to the bottlers.

The productivity of the human sorter could be increased five to ten times by this mechanical assistance. The white-collar nature of the job should attract reliable operators; the job can also offer an incentive bonus based on the value of reclaimed materials. This type of plant could be the intermediate step before coding and sorting are fully automated.

Sorting Without the Human Touch

In reviewing the initial work in multiple-choice sorting which has been carried out at M.I.T. since the summer of 1969, we should like to break down the approaches we investigated into three categories: sorting by sensing different values of a single property in the vortex classifier; sorting by sensing the values of several properties in the series-sensor system; and sorting by sensing a combination of properties in the signature system.

☐ *The vortex classifier*—This machine, related to the centrifugal separators of chemistry and medicine, sorts in one operation by sensing a combination of density and drag, as the zig-zag classifier does. However, instead of the input stream being separated into two streams of "high" and "low" density, the material is distributed in a continuous manner over a range of density-drag combinations.

Particles are allowed to reach an equilibrium position in a radially inward-flowing vortex. The radially inward component of the flow produces a drag force on the particle

which depends on the shape and size of the particle and on the square (approximately) of the inward flow velocity. This velocity increases as the radius is reduced, the variation being dependent on the shape of the vortex chamber. The drag gives a centripetal acceleration to the particle which in equilibrium conditions will be moving in a circular path with no relative velocity to the tangential component of the flow.

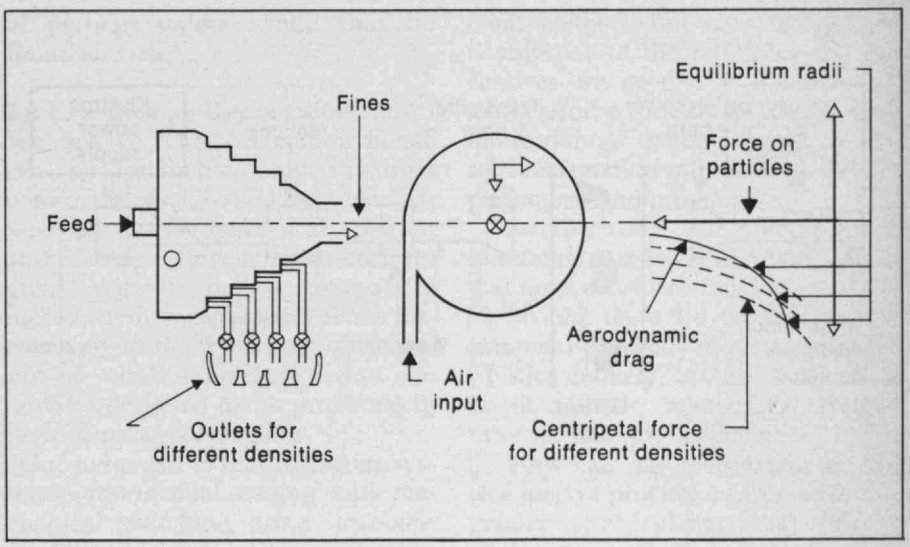
An equation which defines the equilibrium radius for any given type of particle indicates that it should be possible to effect a high degree of separation of materials on a density-drag basis providing that the particles are similar in size and shape. This condition would be met by prior milling and screening.

In preliminary experiments we achieved a high degree of separation of aluminum foil from paper and plastics (even though the particles, produced by a preceding vortex pulverizer, were not necessarily of similar size and shape.) The first trials of a small-scale vortex have given us encouraging results.

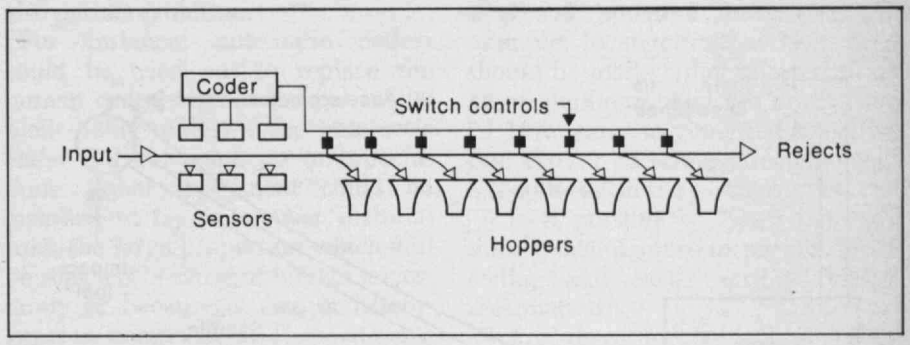
☐ *Multiple-choice series system*—Another sorting alternative is to provide a central logic unit to analyze data from a variety of sensors and then decide the disposition of a given item. The number of sensors needed depends on the number of categories to be sorted, the efficiency of sorting desired, and the amount and accuracy of information available from each sensor. Each sensor would provide an analog output corresponding to a physical property, or composite of physical properties, of each piece of refuse. The logic unit would integrate the data and fit a piece of refuse into a category or reject it as non-classifiable. The logic unit must also keep track of each particle as it passes through the sensor line so that it correlates the information from all the sensors for each particle. The problem is simpler if the refuse-flow system operates at constant speed, as a conveyor belt does.

We have looked at many different sensors that might fit into a series system. One concept is that of the "total spectrum" approach—for example, a system in which a series of sensors detect the interaction of the particle with electromagnetic fields. These sensors may span many decades of wavelength, from radio frequencies to the visible region.

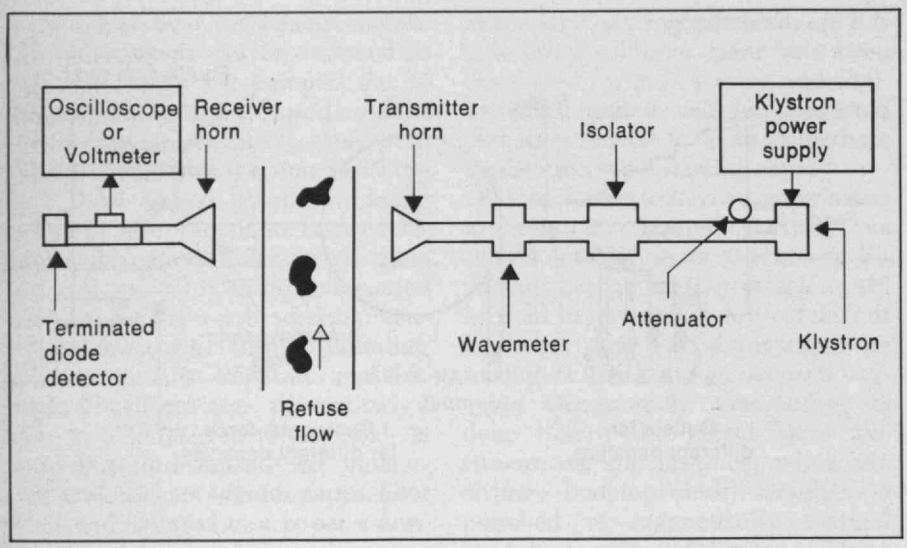
In our experiment materials passed between the transmitter and the receiver horns of a 3-cm-wavelength microwave system. As might be expected, the signal attenuation depended on the material passing between the horns; at the wavelength used, metals appeared opaque, glasses mostly transparent, and pa-



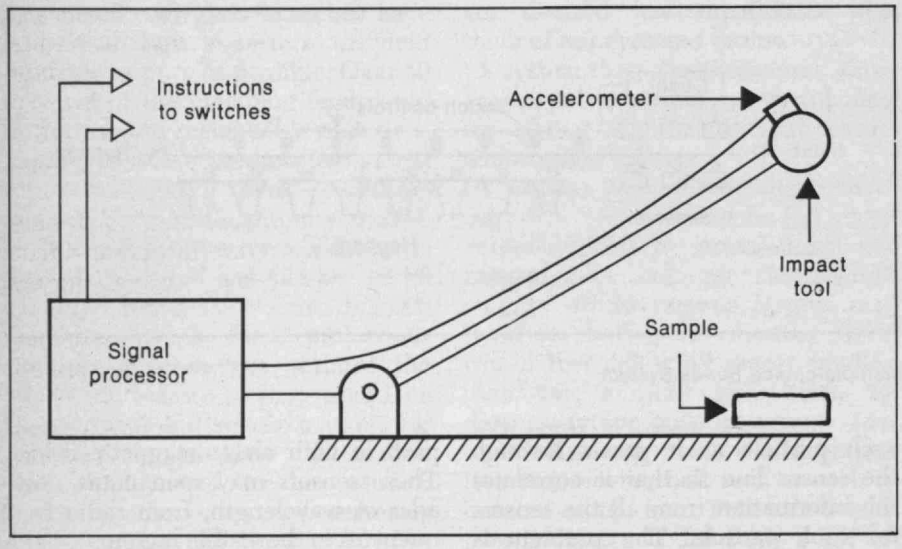
Vortex Classifier



Multiple-choice Series System



Microwave Attenuation Experiment



Impact Signature Device

pers and textiles partly transparent. This information alone was not sufficient for coding, however, because a thick sample of glass can produce the same attenuation as a thin sample of aluminum. Wet paper can be just as confusing. We propose to view the samples at several wavelengths to try to eliminate this dependence on thickness. We may also use water-absorbency to aid in coding. Materials might also be passed through a controlled-humidity environment, then examined by the microwave technique to measure their water absorbency.

We have also been investigating infrared, optical, and spectrographic sensors. There are a number of alternative ways to use an infrared sensor which capitalize on different infrared absorption, transmission, emission or reflection by different materials. Professor Stephen D. Senturia, of the Department of Electrical Engineering, has been pursuing reflectance methods with considerable success. The relative intensities reflected at various wavelengths are measured. The combination of intensities form a "signature" which appears to be unique for a range of samples of typical refuse constituents.

This total-spectrum approach might be sufficient in itself as a sensor system or might be combined with other techniques to form the complete sensor series. The principal problems in coding from surface reflection are to eliminate surface condition, attitude, and geometry. We believe that the combination of signals from several sensors operating sequentially on a single sample will overcome these problems.

☐ *Vaporizing by laser*—Another proposed sensor which includes some of the total-spectrum ideas is a device wherein a high-power pulsed laser or a spark beam vaporizes part of a refuse object. The vapor would then be subjected to spectroscopic analysis. The analysis would have to be very rapid, but this sensor technique holds the promise of providing a large amount of information. Similar flame photometry methods presently used in laboratories are capable of providing highly accurate chemical

analyses of substances.

☐ *Signature systems*—Whenever the output of a sensor is a continuous function analogous to some property or combination of properties of a material, the output is referred to as a "signature." Our experiments with the signature system shown at the left show it to be a promising way to analyze wastes. An accelerometer is attached to a simple impact tool and the two are dropped onto a sample. The resulting impact signature is a time-dependent voltage output from the accelerometer representing the deceleration forces generated when the impact tool deforms the sample. Impacting different materials gives quite different signatures. With the aid of a simple analog computer designed and developed under Professor Senturia's supervision, this instrument is already capable of discriminating almost instantaneously among steel, glass, aluminum and softer materials. A small digital computer to be used on line is currently being programmed, and it is expected that a greatly increased capability will be demonstrated.

This approach uses a heuristic computer program in which the identity of the sample is known. Every correct identification the program makes redistributes the priority-weighting functions among the various algorithms in the program and reinforces those responsible for the correct identification. In this fashion the program "learns" until it reaches a point of optimum efficiency. After the program has "learned" to sort, the analytic algorithms found to be useful in identification can be wired into a relatively simple "black box" of electronic hardware. The characteristics of a signature which make it useful or perhaps unique could thus be found and used.

An Evolutionary Reclamation Plant

We believe that reclamation plants can be profitable now in areas where the costs of alternative disposal are in the region of $10 per ton and perhaps also in lesser-cost regions. We also believe that partly mechanized reclamation plants recovering up to 50 per cent of the input of mixed municipal refuse can now be designed to be profitable in high-disposal-cost regions.

Our judgment is that the series system with manual coding and mechanical switching using near-conventional technology now offers the greatest promise of repaying the investment. Such a system would also permit evolution.

For instance, automatic coders could be tried out to replace the human coder without the risk of the plant being useless if the automatic coder did not come up to expectations. Other equipment could be installed to try to recover material from the large proportion which will be rejected because of human uncertainty or because of size or heterogeneous composition. These streams could be pulverized and sorted by one of the several bulk classifiers being developed. This arrangement would reduce the load on the pulverizer—always expensive in terms of maintenance and power consumption—by removing the large reclaimable items and also the bed springs, rocks, engine blocks, and the like which cause problems in pulverizers.

Many approaches currently underway in many industries and institutions around the country promise to permit more wide-spread use of reclamation as a solid-waste treatment method. But new technology is only one of the requirements. Incentives are needed to increase the market for secondary materials and to encourage manufacturers to design reclamation into their materials, packaging, and products.

Thus there are still a number of questions, and I will end with a few that need consideration:

☐ Should there be government or community subsidy of reclamation?

☐ Alternatively, is the elimination of inequitable regulations, freight rates for example, sufficient?

☐ How can the government or the free market provide incentives to the greater use of reclaimed materials?

☐ How can the government or the free market provide incentives to the design of materials or products with a greater potential for re-use, for example, to suggest that beer cans should be made either all of steel or all of aluminum, and not a mixture?

☐ How can the government or the free market encourage "reclamation-mindedness" in the public?

☐ Is it possible to "tag" materials during manufacture to permit direct coding and easier sorting during reclamation?

☐ Are there mechanical or other aids to sorting that could be applied in the home and factory?

☐ What effect will domestic and commercial compaction systems have on the future possibilities of reclamation?

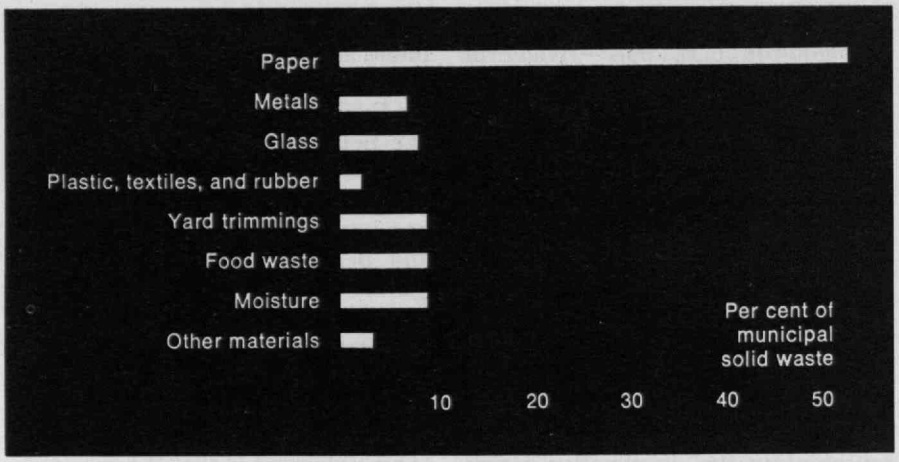
Howard S. Cannon
Research and Development
Department
Continental Can Co.

Can We Recycle Cans?

Disposable metal cans are an essential part of the American food distribution system; almost 60 billion cans are used to package food and personal and household products every year. They represent the lowest cost, most durable, and most convenient method of supplying these commodities to the ultimate consumer. But the empty metal cans represent a disposal problem to the community, even though they are only a very small part of the total waste of the typical householder.

By far the most visual part of the problem are the discarded cans that occur as litter; and as long as human nature does not change, we will never be able to completely eliminate littering by some people. However, vigorous compaigns of the last 15 years have now culminated in can reclamation centers by the aluminum industry and by all the major can manufacturers, and it is estimated that in 1970, about 5 per cent of the aluminum cans manufactured in the U.S. were returned for redemption.

Many centers pay 10¢ a pound for aluminum cans—approximately 1/2¢ per can—and in 1970 almost $600,000 was paid out in this way. This rate of payment does not profit-justify collection of cans by individuals, and the most valuable part of the program has been its education of the general public that discarded cans are a valuable resource, that they should not be indiscriminately discarded, and that they may instead be reintroduced into our distribution system. But reclamation centers will not solve the major problem of resource recovery, which is cans discarded in household rubbish—the primary source of discarded metal values.



Over 200 million tons of household waste are collected every year in the U.S. Metal cans represent only 3 to 5 per cent of this total, but their scrap value at present prices approaches $200 million—less than 4 per cent of which is recovered today. Only 5 per cent of our discarded cans are made wholly of aluminum; they are the most valuable single component in typical municipal waste. Copper recovery is today the largest application for the scrap from the 95 per cent of cans made basically of steel.

The scrap value of the metals in cans discarded in this country approaches $200 million annually. Less than 4 per cent of this valuable resource is recovered today, yet existing technology is fully capable of recovering and recycling better than 90 per cent of these metals. Yet scrap can metal represents less than 5 per cent of the total waste generated in the typical community. This small fraction of the total waste—even though it is valuable—cannot support by itself the cost of processing all waste material if the other 95 per cent is to be discarded. Hence the importance of work such as Professor David G. Wilson's (pp. 31-39) on more sophisticated methods of waste processing which recover the several valuable elements in the waste as important by-products.

Segregating Metallic Wastes

The ideal system for segregating metal scrap for subsequent processing is the sorting of cans by householders prior to pickup. Various communities in the U.S. have required this separation by the householder and have maintained separate pickup service during the last 30 years; Los Angeles proved in the 1960s that reclamation of metal cans so segregated can be a profitable business. The typical housewife is likely to resent having to make this separation in the home, and as a practical matter compliance will not

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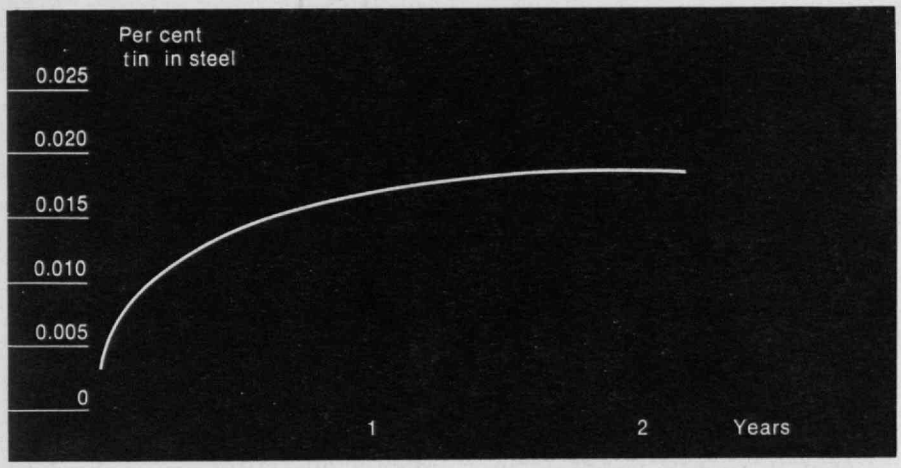
Howard S. Cannon became Director of Metallurgical Research at Continental Can Co. in 1958; he is now Director of Process Concepts in the Company's Research and Development Department. Dr. Cannon studied metallurgy at Carnegie Institute of Technology and Rensselaer Polytechnic Institute; his article is adapted from a paper prepared for the 1971 conference on Chemical Technology for Resource Recovery (American Chemical Society).

Used metallic containers represent an important natural resource. The basic technology for their recovery already exists, and means of combining this into an overall economic process is under development.



As tin can scrap is added to iron ore and the product recycled through steel mills, tin from the can coating gradually accumulates in the steel; the curve shows this accumulation over a two-year period if 10 tons of tin-can scrap are added in each 350-ton furnace charge. The tin content eventually stabilizes at about 0.02 per cent—somewhat above the limit tolerable in high-strength steel but well within the 0.025 per cent limit placed by most steel suppliers for the softer tempers of tin mill products.

be complete even where it is legislated. But even if only 10 per cent of a city of 200,000 population segregated cans in this manner, the cans would have a scrap value of $25,000 per year. On a nationwide basis, 10-per-cent compliance would result in the annual recovery of 500,000 tons of steel and 50,000 tons of aluminum.

But for the long term, segregation of cans by the householder is probably self-defeating, since it is unlikely to yield the bulk of discarded cans and removing a portion of the cans from municipal waste will only discourage separation of the remaining cans at central collection centers. The only effective response must be centralized processing to recover and reuse as much of the valuable elements in the waste as is possible.

The simplest technique for metal can recovery is magnetic separation after coarse shredding of the incoming rubbish. Can shreds so recovered are washed to remove most contamination, given a low-temperature incineration to burn off organic coatings, and baled for shipment to reprocessing facilities.

Two problems arise: Magnetic separation does not recover aluminum cans, and on a per-pound basis these are the most valuable element in municipal solid waste. And since many of today's steel cans are made with aluminum easy-open ends, 3 to 5 per cent of the metal recovered in simple magnetic separation is aluminum. This aluminum is lost in further processing, and it is not an asset in the steel recycling process. Thus an additional shredding and magnetic separation is usually added, resulting in a ferrous residue and a small aluminum-rich fraction which can be separately compacted and returned for aluminum reprocessing. Several other solid-waste reprocessing systems such as those discussed by Professor Wilson in this issue also result in a fairly clean, finely divided metallic fraction.

It is important to note at this point that not all steel cans are identical. Most—some 75 to 80 per cent—are the traditional tinplate material, with the tin coating making up 0.5 to 1 per cent of the total weight. There is incentive to recover the tin coating, since tin has a value of almost $2 per pound and since it causes difficulty in subsequent processing of steel. However, the trend within the can industry is towards tin-free steel cans, and within the next five years tin-free steel and aluminum will be supplanting tinplate as the major can-making material; by the end of this year, tinplate will be used for less than 50 per cent of the total beverage cans.

Incineration of trash prior to separating out the ferrous fractions—the practice today in many communities—changes the recovery problem considerably, depending upon the design of the incinerator and the maximum temperature which it attains. At lower temperatures, from 1000° to 1400°F., ferrous material is little altered, some organic material and fibers remain, and aluminum may tend to be oxidized but generally is not melted and separated from the ferrous fraction.

At higher incinerator operating temperatures, 1400° to 2000°F., practically all of the aluminum is melted off and/or oxidized. Some tin is removed from tinplate by oxidation or alloying with other non-ferrous metals present, but the larger part of the tin remains with the tinplate can to be absorbed into the steel; and once this occurs, no subsequent detinning operation is likely

to be successful. At this temperature range, the steel cans may also absorb up to 0.5 per cent of copper from various copper-bearing sources within the solid waste; and the steel is oxidized to a certain degree. All of these changes tend to impede further processing of the steel scrap in various remelting operations.

Where temperatures of 3000°F. are reached, there is complete alloying of all the metals present, and any glass present fuses to form a slag-like mixture over the molten metal. Subsequent metallurgical processing to recover individual metals is quite difficult.

From the standpoint of processing to recover metal values, intermediate-temperature incineration produces the product most easily handled, even though some metal values are irrevocably lost in comparison to techniques of metal separation prior to incineration.

Recycling Recovered Can Waste

Magnetic separation from municipal waste prior to incineration usually yields a magnetic fraction composed of roughly the following:

	Per cent by weight
Nonmetallics	5
Ferrous materials, other than cans	38
Can metal (57 per cent):	
Iron	53.5
Aluminum	1.7
Lead	0.5
Tin	0.2
Organic coatings	1.1

There are today four major outlets through which this material can be recycled:

☐ The primary steel industry can use limited amounts of scrap; but because of the wide variety of products manufactured and their sensitivity to various impurities, close control must be maintained of at least some elements which occur in scrap. In the most commonly used steel refining operations—the open hearth and the basic oxygen furnace —only 60 and 30 per cent of scrap, respectively, can be used.

☐ Small, localized steel manufacturers, typified by the mini-mill operations that have grown so rapidly in the last five years in the United States, often make only one or two non-critical products, such as reinforcing bars, which are not sensitive to the impurity levels normally found in can scrap. Since these mills do most of their melting in electric furnaces, there is little or no limitation on the amount of scrap which they can add to any particular heat of metal.

☐ Since iron foundries are ubiquitous in this country, especially in municipal areas where large amounts of can scrap are generated, they seem ideally suited to reprocess can scrap. But cast iron is much more sensitive to certain alloying elements than is normal steel, and so foundries must exercise great care in controlling impurity levels.

☐ The copper industry can recover copper using iron by the same leaching process which is used on low-grade ores, and this is in fact the single largest application for recycled cans at the present time. Impurities in the scrap are not important as long as large areas of relatively unoxidized steel surfaces are present. Since facilities for such processing are associated only with copper mining operations in the southwest, high shipping costs generally limit this use to scrap generated west of the Mississippi River.

But over 100,000 tons of shredded steel cans—2 to 3 per cent of the total cans produced—will be used in this way in 1971 in the U.S.

The Effects of Impurities

The presence of organic coatings on cans may be detrimental for the first three applications listed above; these involve remelting of the scrap, and organic materials in the melting furnace burn off very rapidly, producing a great amount of flame and fume. While measures can be taken to control these pyrotechnics, a preliminary low-temperature treatment to burn off the organics and to eliminate water which may have accumulated in the scrap is usually desirable.

Lead from the solder used in tinplate cans is not considered detrimental, since it has a very low solubility in molten steel. However, because of its high density and low melting point lead can penetrate the joints between refractory bricks in melting furnaces and cause molten steel breakouts. This is especially a problem in the large open hearths which have been the mainstay of the steel industry in the last 50 years; it is less serious in the basic oxygen furnace which has been replacing the open hearth as the primary steel finishing furnace in the last 10 years —probably because of the much shorter cycling times and turbulent action in the new furnaces. Most of the lead present in the scrap is driven into the dust collectors, along with fine particulates of iron and iron oxide. Recent tests indicate that this lead can be recovered from the dust; if recycling of steel cans becomes extensive, this could become an important secondary source of lead.

Lead affects the graphite flake morphology of cast iron, and the

permissible limit of lead in the final product is therefore placed at 0.01 per cent. This problem has discouraged the use of lead-bearing scrap in the foundry; but since lead oxidizes easily and is volatile, careful foundry operations may eliminate almost all of the lead introduced in scrap, and independent foundry trials are now being made by Continental Can Co.

Tin in small amounts (less than 0.1 per cent) strengthens both steel and cast iron, but in larger amounts it can cause embrittlement. Since tin tends to segregate upon solidification of steel, small amounts can have a disproportionate effect on the ductility of the product. Tin is resistant to oxidation during normal steel refining operations and has a high boiling point; therefore, it is not easily removed. In essence, once tin is dissolved in steel it is never removed by subsequent processing. For these reasons, metallurgists are concerned over the possible buildup of tin in steel through the constant recycling of inplant scrap. The conclusion is that use of tin-containing scrap for noncritical items should be acceptable short-term, but there may be long-term problems with high-test steels if control is not maintained.

The presence of small amounts of tin in cast iron is actually considered advantageous; indeed, Chrysler Corp. makes a deliberate addition of 0.04 per cent of tin for strengthening automotive cast iron. Foundries without sophisticated analytical and quality control procedures are more hesitant to use scrap sources that may introduce uncontrolled amounts of tin. Nevertheless, tin-bearing scrap should be acceptable as part of the charge for an iron foundry.

Copper, like tin, is relatively stable and difficult to remove from steel in normal refining operations; in quantities of 0.05 to 0.2 per cent, copper added to certain steel compositions improves strength and resistance to atmospheric and chemical corrosion. Copper should present no problem to users of unincinerated can scrap, but incinerated scrap may be introduced only judiciously in steelmaking operations to prevent undesired buildup of copper. The relatively low levels of copper in can scrap should be completely acceptable in foundries.

Aluminum presents a number of problems in steelmaking, but its strong reaction with oxygen makes possible its removal from steel in normal processing. All of its effects are controllable by a furnace operator who is familiar with the composition of his scrap charge and the requisite adjustments that must be made. Aluminum is commonly restricted to 0.01 per cent of cast iron, but scrap used in foundry operations may contain somewhat more than this amount because some aluminum is lost in melting.

To summarize, while the recycling of the ferrous fraction of solid waste presents problems to the steel and foundry industries, all seem to be solvable by presently known technology; research and tests to determine how steelmaking and foundry operations should be modified to handle ferrous solid waste scrap and how much scrap can in fact be added in various metal refining operations is now in progress in many mills. A recent large-scale test at National Steel Corp., Weirton, W. Va., for example, has demonstrated that up to 10 per cent of the scrap used in a basic oxygen furnace could be unincinerated beverage cans containing almost 10 per cent aluminum. Up to 20 per cent of the total scrap can be all-steel (non-aluminum) cans without causing problems with steel chemistry.

As a result of data from these tests, Dennis Carney, Vice President of U.S. Steel Corp., testified in Washington in 1970, representing the American Iron and Steel Institute, that major steel companies will now accept any properly prepared scrap cans, without the removal of tin or solder, for recycling in the steelmaking operation. The material should be cleaned, magnetically separated at least twice, shredded, and compacted; so prepared it would be purchased by the steel industry at regular bundled scrap prices, currently about $25 per ton. Though widespread use of scrap cans by the foundry industry awaits the completion of further research, it now appears that foundries will prefer incinerated scrap in order to eliminate the aluminum and lead impurities detrimental in foundry remelting.

Aluminum Can Recovery

On a per-pound basis, as noted previously, aluminum can scrap is probably the single most valuable element in typical municipal solid waste. Properly prepared aluminum scrap is valued at about $300 per ton delivered to an aluminum remelting facility—and this implies a price of about $200 per ton at the point of collection.

But separation of aluminum from other waste is difficult; it cannot be selected by magnetic methods, and it is present in very small quantities, usually estimated at less than 0.5 per cent by weight of solid waste matter. More sophisticated solid waste separation systems, including some of those proposed by Professor

Wilson elsewhere in this issue, should permit segregation and recycling of aluminum within the next few years. In the meantime, aluminum will probably make up the principal element in the non-magnetic residue resulting from secondary magnetic separation after shredding. This aluminum will be contaminated with the other common non-ferrous metals—zinc, lead, and copper—which will lower its value as a prime alloy element. However, small amounts should be usable if added judiciously in the aluminum casting process. Small amounts of iron not removed by magnetic separation are the most detrimental element typically found in segregated aluminum scrap; fine shredding and a second magnetic separation is sometimes required.

Because of these problems, most recycled aluminum cans now come through the reclamation centers set up by the aluminum industry and can manufacturers, and this procedure will continue to prevail in the immediate future. Over 115 million aluminum cans—almost 5 per cent of those produced—were returned in this way in 1970, and almost $600,000 was paid for their return. With additional reclamation centers in operation, it is predicted that approximately 10 per cent of all aluminum cans will be recovered in this fashion in 1971.

Virtually all of these aluminum cans are in fact 100 per cent aluminum—that is, both the body and the end are aluminum—and contamination—except by occasional steel cans inadvertently submitted with the aluminum—is a minor problem. Some type of treatment is desirable, however, to remove organic coatings from the aluminum (which otherwise can cause fume and flame problems in remelting) and to eliminate moisture (which can cause serious explosions in aluminum furnaces). Recovered aluminum cans are now shredded to inch-size segments, and steel scraps and bi-metallic cans are removed magnetically. The shredded scrap is pneumatically processed to remove aluminum fines, traces of paper, dust, and other non-magnetic contaminants to eliminate explosion hazards. Better than 90 per cent of the aluminum charged actually becomes part of the melt and ultimately finds its way into the new canmaking sheets, thereby making this a truly complete recycling system.

Taking a Longer View

The technology exists today for the separation and recovery of many elements in solid waste, but the use of this knowledge has been limited by the simple economic fact that throwing away all solid waste material has been cheaper than recovering even the more valuable elements of it. As we recognize the need to conserve our resources and as low-cost dumping sites disappear, more sophisticated reclamation processes will gain support.

Much still needs to be done. Federal and state laws which favor the use of virgin over reclaimed materials must be changed; we must eliminate indirect subsidies in terms of depletion allowances and special shipping rates that have been given to the virgin material industries (a good example of the latter is the fact that iron ore can be shipped by rail at only $1.64 per ton while steel scrap may pay as much as $4.12); and we should revise unduly restrictive and obsolete impurity specifications for various grades of steel.

Local governments and the people that make up their constituencies must appreciate the need to conserve our resources and to accept the small economic penalty required at this time to more fully recover valuable elements from solid waste. If our citizens are willing to pay $4 billion for scrap and rubbish collection, they must understand that an investment of up to $2 billion more is likely to make possible full recovery of the valuable elements in solid waste. This cost for extra separation must be seen as the price paid for the convenience and other assets of one-way packaging. It can be raised directly from householders in terms of increased rubbish pick-up charges or indirectly from manufacturers and packagers by a tax to be added to the price of the goods involved. The dangerous possibility is that this philosophy will be implemented by selective taxation or penalties which only affect a portion of the packaging industry and which ultimately distort our distribution system and perhaps introduce more problems than are solved.

V. R. Srinivasan
Professor of Microbiology
Louisiana State University

Biodegradation of Waste Plastics

Synthetic polymers present an inherently difficult waste disposal problem. Possibilities include conversion into oils rather like those they are made from—but may polymers instead be returned to the natural eco-system?

The new industrial revolution presents a central challenge: to devise cycles that will conserve our non-renewable resources, at the same time limiting the accumulation of processed materials as useless or harmful wastes, and halting the disruption of the ecological cycles of other species. This article considers that challenge in the particularly obdurate case of synthetic polymers.

Synthetic polymers are manufactured from raw materials obtained from the cracking of petroleum—in essence, they are derived from the so-called "fossil fuels." In the U.S. alone, the production of polymeric materials in 1970 amounted to 24 billion pounds, and the Technomic Publishing Co., in a computer simulation of the chemical industry, predicted that in 1971 the production would reach about 29 billion pounds. The applications of plastics now range from structural materials for building and construction, to fabrics, squeeze-bottles, adhesives, food wrappers and even shoes.

The type of plastic selected for a particular product will generally depend upon a combination of minimum cost and desirable properties. For example, materials which will be exposed to outdoor conditions will be selected from among the plastics more resistant to weathering, such as acrylic, chlorotrifluoroethylene and vinylidene fluoride. On the other hand, polystyrene, polyethylene, polysulfones and many other thermoplastics are adequate as package materials. Since the synthetic plastics are used in a large number of consumer products it is not surprising that an enormous amount of plastic waste is generated in our society. It was reported by the Battelle Institute that in 1966 the total amount of plastic waste generated in the U.S. was approximately 3.8 billion pounds, and it is estimated that by 1976 total plastic wastes will be 9.5 billion pounds per year, of which packaging refuse alone would account for 70 per cent of the total.

These synthetic polymers, unlike organic chemicals of biological origin, are resistant to biodegradation by bacteria or fungi. Hence they tend to accumulate, and are particularly troublesome to those concerned with solid waste management. It seems to me that any rational approach to the management of plastic waste must consider not simply the economics of the process but also the possibility of reclaiming and recycling the raw materials.

Let us try to place this idea of polymer recycling in its natural context. In order to sustain the thin film of living matter we call the biosphere, a delicate balance must be maintained between reduction and oxidation: reduction of carbon dioxide in plants, using solar energy, to form organic compounds and molecular oxygen; and oxidation of the reduced materials, living or dead, by atmospheric oxygen to produce carbon dioxide plus energy for physical activity, growth and reproduction. Before the industrial revolution, man depended entirely upon recently arrived solar energy. The energy which comes from the metabolism of food, or that obtained by burning wood or oils of animal or vegetable origin, or even the energy of windmills and watermills, represented the conversion of recently arrived solar energy. But by releasing the energy stored in fossil fuel, man has increased his use of energy—and hence his needs—100-fold. Today, per capita use of power in the U.S. is 10,000 watts; in many parts of the world it remains on the same order as the unaided human energy output, 100 watts.

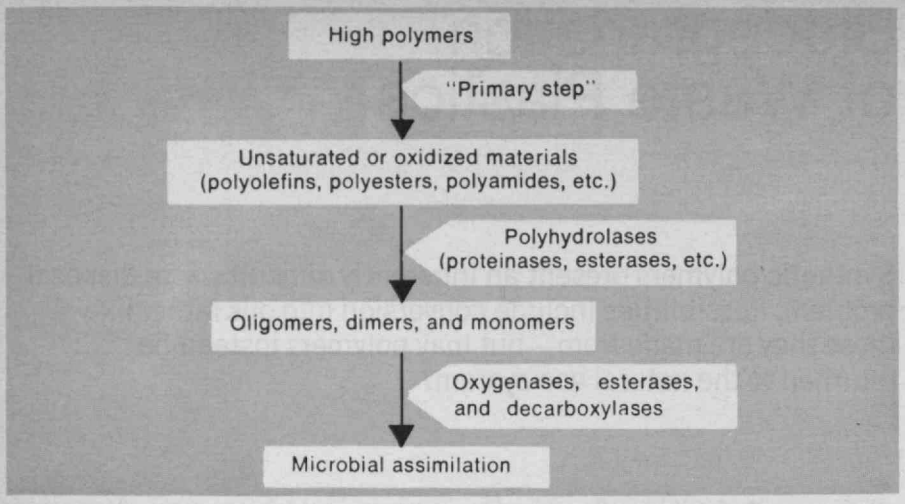
Recycling versus Burning

At present between five and six billion tons of fossil carbon are being released per year. It took millions of years for this fossil fuel to form by the decomposition of organic matter—it is a non-renewable resource. Synthetic plastics are manufactured from the same non-renewable resources. So we must ask ourselves whether, once used, they must necessarily be discarded.

What are the possible approaches to the disposal of synthetic plastic wastes? There are different schools of thought in this field. The major lines of investigation are directed toward three areas of study, namely incineration, pyrolysis and biodegradation.

First, incineration: A complete oxidation of the organic material ends in—primarily—carbon dioxide, which escapes into the atmosphere, and water vapor. The total amount of carbon dioxide which would be released by all forms in which fossil fuel is used presently is sufficient to increase that present in the air by 2.3 parts per million per year, if it is uniformly distributed and not removed. On the other hand, it has been shown by Wright and Wood-

V. R. Srinivasan is a microbial chemist and physiologist whose research includes the genetics of industrially important organisms and their continuous fermentation. He came to the U.S., with doctorates from the Universities of Madras, India, and Mainz, W. Germany, in 1956. He moved to Louisiana in 1965, after nine years spent mainly at the University of Illinois.



The degradation of a high-molecular-weight polymer to simpler compounds, which can be assimilated into the natural food-cycles, takes place—if at all—in a series of steps. There are organisms which can perform the lower steps but cannot attack the large molecules characteristic of synthetic polymers. The first step must therefore be carried out in some other way, perhaps by prearranged radiation-induced changes.

well at Brookhaven National Laboratories that the amount of carbon dioxide which is fixed photosynthetically by leaves increases linearly with the concentration of carbon dioxide in the air. This increased photosynthesis would tend to increase the total energy stored in natural eco-systems. (And, indeed, it appears that the industrial CO_2 output is being absorbed about equally by the atmosphere, the ocean, and the biosphere.)

But this single-factor type of analysis may in fact be misleading, since the side-effects of the increase in atmospheric carbon dioxide—such as change in atmospheric temperature and increased generation of natural wastes—may result in a loss of regulation of the eco-structure. In any case, total incineration of the organic material obtained from fossil fuels leads to an irretrieveable loss of a natural resource.

The second approach, which at least is an attempt at a partial recovery of organic material from synthetic plastic waste, is a process of continuous pyrolysis, the technology of which has been extensively developed by Union Carbide over the last fifteen years. The process differs from destructive distillation in that no carrier gas is used, the process is nearly isothermal, and only a small amount of gases and carbon are formed. The product obtained by pyrolysis of a mixture of polyethylene, polystyrene and polyvinyl chloride resembles crude oil or petroleum, with certain notable differences. (One of the more significant differences between the pyrolyzate and crude oil obtained from fossil fuel is the absence of polynuclear aromatic hydrocarbons.) In addition to this "oil", pyrolysis yields several hard and soft waxes which can be easily recycled into our economy.

The third possibility for the ultimate disposal of plastic wastes is biodegradation. Biodegradation is perhaps the best way of injecting the organic material into the eco-system without seriously altering the structure and regulation of the latter. Aerobic decomposition of fresh organic matter results in its initial conversion to humus, followed by a breakdown of the humus to simple gaseous and mineral constituents. Humus, then, is essentially restructured organic matter—from the microbial manufacture of tissues and metabolic products—which becomes dispersed among the mineral particles of the soil.

As of today, the plastics which are extensively manufactured are not directly amenable to microbial attack. As a matter of fact, it has been the concern of the plastics manufacturers to deliberately reduce deterioration due to environmental and microbial effects. Several test systems have been devised to assay for the biodegradability of synthetic polymers. Fungal activity on polyurethanes (for instance by *Cladosporium resinae*) had been noticed in jet aircraft fuel-supply systems, to cite one example of natural, unwanted biodegradation.

But, to the gratification of the plastics manufacturers (though not of those interested in solid waste management), the organic polymers which form the main components of most plastics are not susceptible to attack by microorganisms. It is mainly the plasticizers used to mold and form the polymers into shape that are decomposed by bacteria and fungi. Certain species of *Aspergillus* utilize these plasticizers, such as triacetin, tributyrin and dibutyl sebacate, as carbon sources for their growth and metabolic activity. Materials made of polyethylene have been found amenable to composting: they degrade into fine particulate material. This is perhaps due not to the actual degradation of the polyethylene but to the decomposition of plasticizers by microorganisms.

Helping the Microbes

In order for insoluble organic materials to be metabolized by microorganisms, they must be broken down into molecules of such molecular weights as to be assimilable by these organisms. The successive steps which are involved in the breakdown of high polymers may be schematically represented as shown in the above chart.

Most of the plastics are recalcitrant to microbial decomposition for the primary reason that the organisms lack the ability to carry out the first step, and sometimes also the second, shown in the scheme. This is what would be expected of some of these materials, which are man-made, of fairly recent origin, and do not resemble the molecules that are usually synthesized in nature. Presumably evolution has not equipped the microbes with the necessary enzymes to digest molecules of the type of polyethylene.

In the case of cellulosic polymers the story is different. There are organisms in nature which excrete certain hydrolase enzymes known as cellulases, which hydrolyze the B-glucosidic bonds of cellulose, breaking it down into molecules of low molecular weight. Similarly, a few polyesters or polyamides may be degraded by esterases of bacteria or fungi.

But generally, in nature, the primary step in the degradation of

It should be possible to chemically design polymers so as to facilitate their degradation after use. True "throw-away" plastic ware is indeed a feasible proposition.

macro-molecules is contributed by certain physicochemical processes, notably photochemical reactions, thermal decomposition, and changes in the local hydrogen-ion concentration (acidity or alkalinity). The general effects, in any case, are to bring about either a scission of the main polymer chains or various atom-substitution reactions. So, to make the more obdurate plastics biodegradable, it is necessary to examine the different functional groups present in their molecules and to discover how to carry out the "primary step" under controlled conditions. This amounts to saying that a new chemical technology of "reverse synthesis" has to be developed.

The "weathering" of plastics that often occurs on exposure to outdoor conditions is well known. Manufacturing industries are fully aware of it, and research on high polymers has been directed at counteracting the "weathering" phenomenon by finding ways to stabilize polymers. Valuable data have been collected regarding the effects of irradiation.

It turns out that the range of wavelengths most effective in oxidation and scission of polymers is in the ultraviolet region—most of the plastics which are vulnerable to irradiation have molecules which absorb in the ultraviolet. These molecules, when irradiated, become excited into transition states, and regain stability either by bond rupture, resulting in two stable molecules, or by the release of free radicals. Free radicals thus formed may initiate a chain reaction, leading to depolymerization to compounds of low molecular weight.

In either case the final products of the reaction are more easily degradable by microorganisms. Armed with such knowledge and experience in the field of synthesis and degradation of high polymers, it should be possible to introduce functional groups into the polymers during their syntheses, such as to facilitate their degradation after utilization. Such a type of high polymers could form the basic materials for the manufacture of true "throw-away" plastic ware, which when exposed to sunlight (a good enough source of ultraviolet radiation) will depolymerize to molecules easily assimilated by micro-organisms.

Such an approach is not simply an exercise in intellectual gymnastics, but is indeed a feasible proposition. This has been borne out by the excellent work of Dr. J. E. Guillet and his associates at the University of Toronto in Canada. They have successfully synthesized high polymers interspersed with light-sensitive groups. These polymers, when irradiated, cleave off at bonds adjacent to the sensitive groups.

Retrieving the Monomers?

Since the synthetic polymers are derived from organic chemicals obtained from the cracking of petroleum, which is of fossil origin and non-renewable, is there a possibility of regenerating monomers from the wastes? Several studies on the thermal decomposition of pure polymers have shown that various polymers undergo degradation reactions due to the formation of free radicals, resulting in varying yields of monomers, dimers and trimers. For example, polystyrene and ring-substituted polystyrenes break down thermally into a mixture consisting of 40 per cent monomers with decreasing quantities of dimer and tetramer.

But at the present state of plastics technology such a recovery program is not only uneconomical but also unfeasible. For the plastics are made from a wide variety of synthetic polymers, and it is nigh impossible either to separate them into polymers of one kind before depolymerization or to fractionate the monomers after the degradation process is complete. This type of recycling seems to require an efficient method of identifying and sorting the synthetic polymers in the various items manufactured.

Here the development of biodegradable detergents indicates an alternative way of approaching the problem. By continued research effort and proper legislation, it is highly likely that we may be able to restrict the number of synthetic polymers which may be used in the manufacture of "throw-away" plastics. This would definitely have economic advantages, lessening the costs both of recycling and of pretreatment for biodegradability.

The cost of the initial effort may be considered as a premium for insurance of the continued progress of our civilization, so that our achievements can be enjoyed not only by us but also by our children and the generations to come.

Suggested Reading

Irradiation of Polymers, Advances in Chemistry Series, Vol. 66.

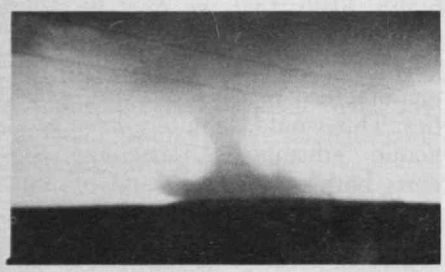
Stabilization of Polymers and Stabilizer Processes, Advances in Chemistry Series, Vol. 85.

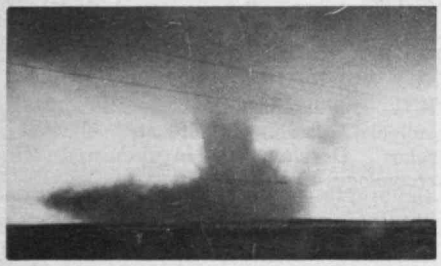
R. L. Huddleston and R. C. Allred, "Microbial Oxidation of Sulfonated Alkylbenzenes", *Developments in Industrial Microbiology,* 4:24-38.

R. D. Swisher, "Biodegradation of ABS in Relation to Chemical Structure", *J. Water Pollution Control Federation,* 35:877-892.

Edwin Kessler, Director
National Severe Storms
Laboratory

On Tornadoes and Their Modification





A major tornado presents the atmosphere's most extreme concentration of vorticity. It is always part of a convective storm, which usually also harbors much hail and lightning. Most reported tornadoes produce effects similar to those associated with hurricane winds, while one or two in a hundred present a truly awesome appearance and leave awesome consequences in their wake.

These one or two per cent account for most of the approximately 125 persons killed annually by tornadoes and for most of the $75 million annual average damage to property. The rains associated with convective storms are often beneficial; the damage and loss of life they cause are the main bases for our efforts to provide effective forecasts and warnings of them. We are also interested in the distant prospects for channeling the energies of severe storms into beneficial courses.

On the basis of numerous visual sightings and photographic evidence, occasional wind records near tornadoes, and inferences from the distribution of precipitation near tornadoes, there can be no doubt that the primary vertical current of the tornado is vigorously upward. Associated with this updraft is a horizontal convergence of air at low altitudes; because angular momentum tends to be conserved, and there is usually some degree of rotation in the surrounding wind pattern, the horizontal convergence results in the characteristic rapid spin near the tornado's axis. There is a well-known class of severe traveling thunderstorms which tend to generate severe tornadoes at a characteristic location in the pattern of precipitation and wind. The occasional accurate recording of such patterns, as shown in the illustration opposite, has been facilitated by equipment installed by the National Severe Storms Laboratory in Oklahoma, including a weather radar and a network of stations for observing winds, pressure, temperature, and amounts of rainfall. But the N.S.S.L. station network has its surface stations spaced five miles apart—too wide to depict the structural details of a tornado.

The width of a tornado's damage path varies from practically zero to as much as a mile. Reliable measurements of the extreme conditions are inevitably lacking, but inspection of damage paths and study of the literature suggest that a considerable proportion of tornadic damage is associated with winds at speeds of about 100 kn., while speeds of 200 kn. seem to occur occasionally. When they do, residential areas may be virtually obliterated, since the forces produced by the wind are roughly proportional to the square of its speed.

Rapid fluctuations of the local static pressure are associated with a tornado's forward motion—it can travel at up to 70 kn.—and with the motion of smaller intense vortices

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Edwin Kessler has been Director of the National Severe Storms Laboratory since 1964, following three years as Director of the Atmospheric Physics Division of the Travelers Research Center, Hartford, Conn. His earlier experience was with the Weather Radar Branch of the Air Force Cambridge Research Laboratories, during which period he obtained his M.I.T. doctorate. A former National Councilor of the American Meteorological Society, Dr. Kessler is currently an Associate Editor of the *Journal of Applied Meteorology*.

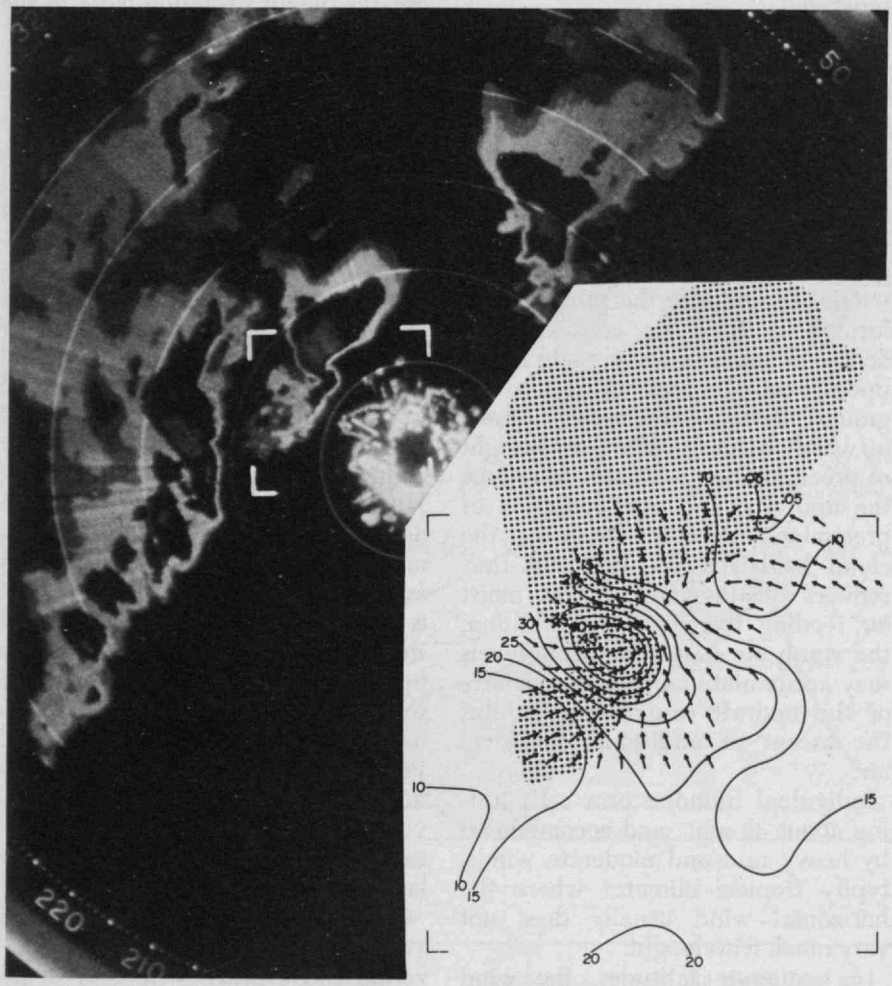
Tornadoes are inherently difficult to study close up. The one shown on these pages, at Hammon, Oklahoma, on June 10, 1967, was photographed by Gayle Crow.

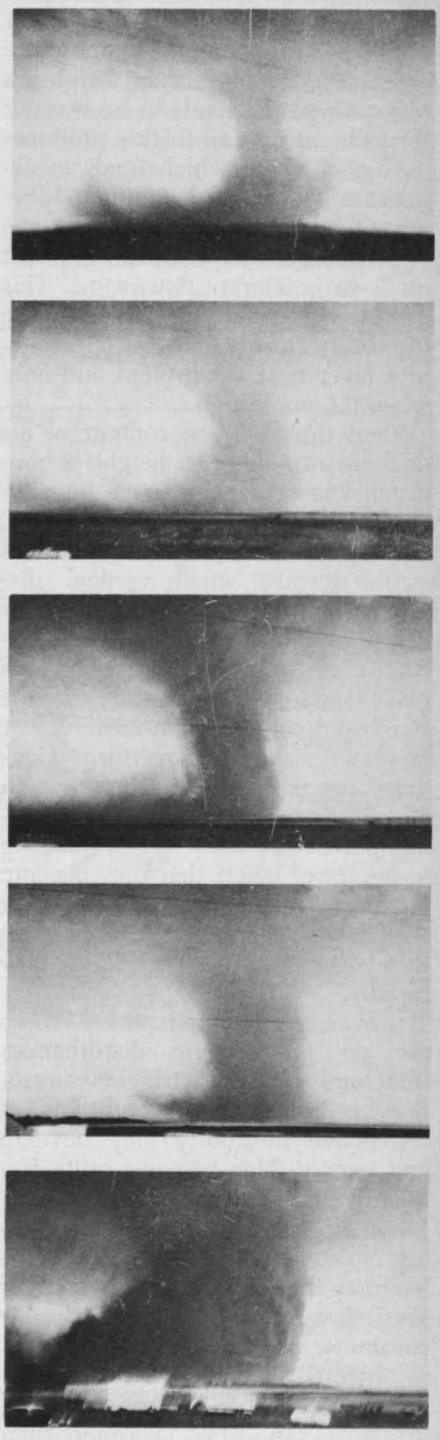
Our present rather sketchy understanding of tornadoes suggests a number of possible methods of control, most of them prohibitively expensive or requiring better instrumentation than is presently available. The best advice is still "Be prepared."

around the core. Much tornado damage has traditionally been ascribed to a rapid fall of the ambient pressure near the center of the tornado. In fact, the transient pressure differentials produced by the interaction of wind and obstacles are of the same order as this ambient pressure drop —perhaps 10 per cent. George Reynolds has considered the effects of such pressure fluctuations on houses, and he recommends providing vents: a vent area of only 1 sq.ft./1000 cu.ft. would allow a pressure change of an inch of mercury in two seconds with the airflow at the vent averaging only about 15 ft./sec.

The Physics of Storms

The primary source of energy for





A tornado which passed through Oklahoma City at 12:45 a.m., April 30, 1970, was recorded by 10-cm. radar at N.S.S.L. Wind speed in knots and wind direction as recorded by surface stations are shown in the inset, lower right. The tornado is a detail near the forward edge of the hook-shaped appendage and is inadequately portrayed by the surface stations, which are spaced at 5-mile intervals.

the air motions in thunderstorms is a particular vertical distribution of temperature and water vapor. Since pressure declines with height, rising air expands and in doing so becomes cooler. (As in a heat engine, it loses thermal energy by doing work on its surroundings.) We refer to the *potential temperature* of an air parcel: the temperature which it would reach by this mechanism in rising or falling until it reached a standard pressure. If the atmosphere were in equilibrium and behaved in a classically simple fashion, its potential temperature would be the same at any height. In fact, it varies, and the variation is important.

When the potential temperature declines with increasing height, a rising air parcel tends to be warmer than the air around it; this produces a buoyant force which tends to accelerate its upward motion. Likewise, a falling air parcel in the same atmospheric temperature gradient tends to accelerate downward. This condition is referred to as absolute instability, and usually occurs only in a layer near the ground and only when the sun is high.

When the moisture content of air declines rapidly with height, a condition known as convective instability frequently exists. In such a case, although the atmosphere remains stable toward small vertical displacements of either the moist air below or the drier air above, it becomes unstable in relation to displacements large enough to produce significant condensation in the lower layers—it tends to overturn. Condensation releases latent heat, which may so raise the temperature of rising parcels of moist air originating in the lower layers that they become much warmer and lighter than the dry upper-level environment through which they then rise rapidly.

If, over an extended period, there are no atmospheric disturbances sufficiently large to trigger convection, rather extreme conditions of convective instability may develop and persist. This happens quite frequently in the lee of the Rocky Mountains, where northward-flowing moist air from the Gulf of Mexico may be overlain by a cap of sensibly warm and extremely dry air constantly renewed from the desert southwest. Then, where a large-amplitude disturbance appears, updrafts 5° to 10°C. warmer than their environment may be started; in extreme cases, the speed of such updrafts may become as great as 150 ft./sec.

Some insight into storm and tornado characteristics is also provided by simple conservation laws. For example, the air which rises must be replaced and must itself disperse. Hence, for any rising column there must be horizontal convergence at lower altitudes as well as horizontal divergence (commonly manifested in outflowing cloud) above. If the updraft column is large in diameter, the horizontally convergent winds must be correspondingly strong, other factors being the same. At the same time, the larger the column the smaller the effect of mixing in assimilating it into its surroundings. On both counts, we can expect larger storms to be more intense. On the other hand, a limitation is placed on the size and intensity of convective storms by the inefficiency of energy conversion when updrafts and downdrafts become very widely separated.

A rising air column may encounter variations of horizontal wind at different heights. Such variations are believed to affect storm behavior significantly, for they tend to displace a raised air parcel horizontally in relation to the rising air column. This removes a natural brake on the growth of a storm, for if horizontal winds are uniform, the precipitation formed in lifted air as it expands and cools tends to accumulate in the updraft column, and fall back to the ground through the same updraft in which it forms. The very weight of precipitation then tends to reduce the updrafts; and re-evaporation of precipitated water beneath the cloud base absorbs heat and thus reduces the buoyancy of the moist air feeding the cloud. In addition, the warm air raised from low levels may accumulate aloft in the vicinity of the updraft column and inhibit the ascent of additional low-level air.

Individual thunderstorm cells lasting about 30 min., and accompanied by heavy rain and moderate winds, typify tropical climates where the horizontal wind usually does not vary much with height.

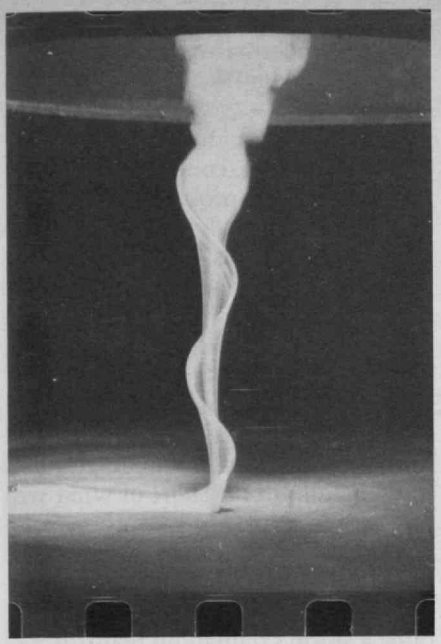
In temperate latitudes, the wind tends to become westerly with increasing height and to increase in speed (a well-known consequence of the poleward temperature gradient, and most pronounced when temperature contrasts are strong). The large-scale weather systems of the middle latitudes are associated both with locally strong temperature contrasts and with localized disturbances which may trigger overturning, given the instability latent where there is warm moist air at low altitudes. The precipitation formed in the rising moist currents, displaced horizontally, falls outside of the updraft that produced it. If the precipitation descends through "potentially cold" air at middle levels, the cooling induced by its evaporation there increases the downward motion of the descending branch of the storm circulation. Furthermore, the risen warm air may be moved rapidly away from the rising column by strong upper winds, removing the obstacles to further up-flow. In such a case, the storm may be intense and persistent, and low-level convergence, continuing to act on the same inflowing current of warm air, strongly increases the air's rotation close to the rising column.

Imbalance and Feedback

Though we believe that all thunderstorms have significant updrafts, only a few seem to generate strong whirlwinds. The most important tornadic storms are usually associated with vigorous larger-scale disturbances, where horizontal convergence has stepped up vorticity over a wide area, and where horizontal temperature gradients (which lead to wind variation with height) provide the conditions essential for enduring local storms.

In trying to imagine how a tornado develops, we think of possible connections among the physical processes involved. Since a thunderstorm is a highly turbulent phenomenon, it may be appropriate to think partly in statistical terms, i.e. to consider what kinds of events are likely to happen *somewhere* in the system. Perhaps an especially strong and enduring rotating updraft owes its development to a combination of factors that arises by chance, sooner or later.

Once this strong rotating updraft (not yet a tornado) is formed, horizontal convergence will tend to increase the spin, while mixing and viscosity (particularly near ground-level objects) will tend to dissipate it. The former will be of greater in-



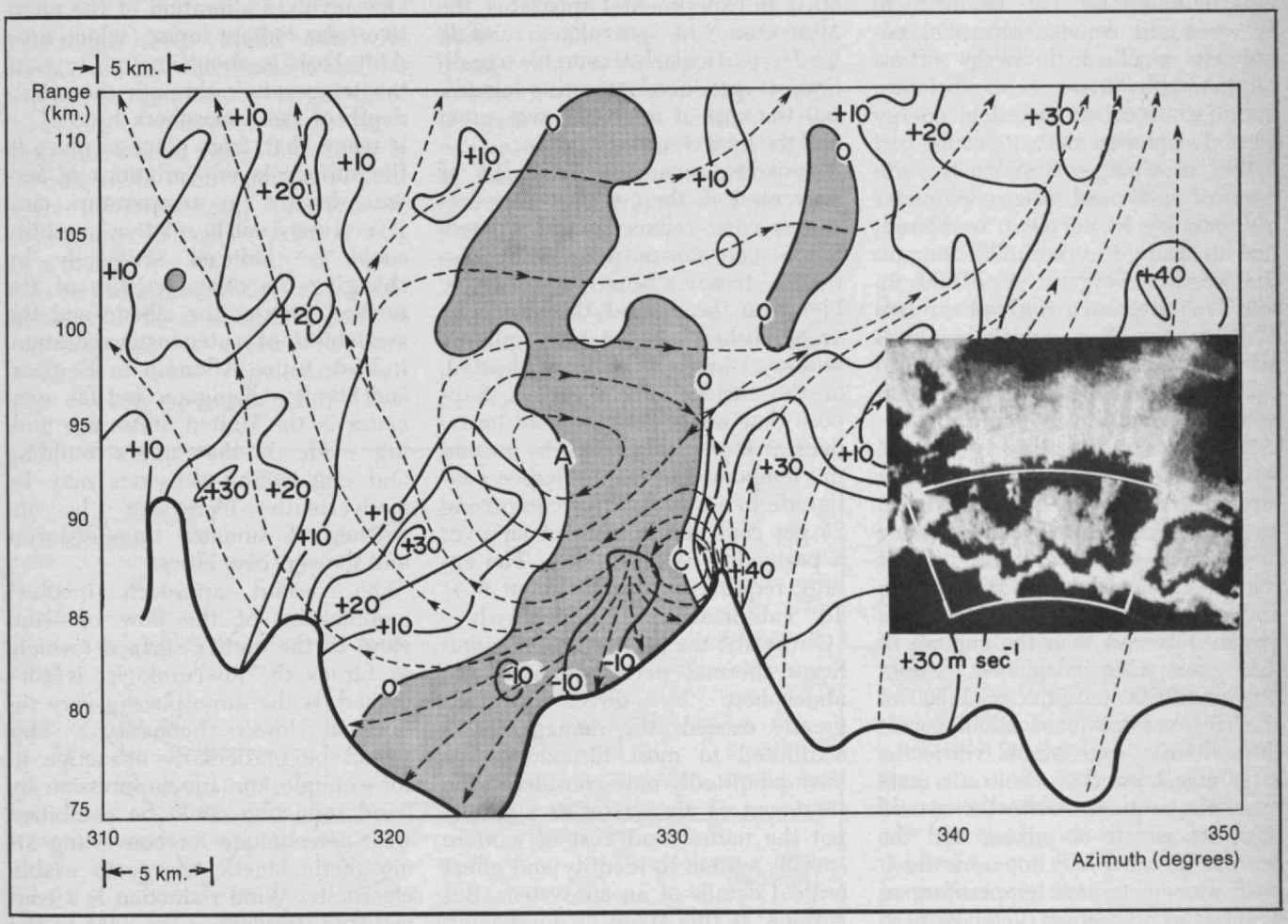
In an experimental apparatus developed by Neil B. Ward, the vortex characteristic of a tornado is revealed by a smoke tracer. The laminar-flow section extends to a height which can be controlled by changing the experimental variables.

fluence when the background rotation is already large (because the rate of vorticity development by convergence alone is proportional to the vorticity itself). It is a property of vortex motion that it tends to restrict the horizontal movement of air within the vortex; with the establishment of a vortex, therefore, mixing may decline, permitting the vortex to become more buoyant and intense. Surrounding warm air would flow upward and inward toward the vortex center to a distance where centrifugal force balances the horizontal inward pressure gradient (the latter governed by the relative warmth of the vortex column). Rising air within the vortex would be replaced by air from below, and as the base of vortex motion thereby descends, air would be drawn from the progressively lower and warmer levels. This would produce within the vortex a progressively warmer temperature and should thereby promote its still further intensification. However, the vortex size and intensity are related to the atmospheric instability and to conditions at ground level in a complicated fashion, still poorly understood.

While this discussion of storms may have some appeal, it is at best very sketchy and highly speculative, and it lacks the support that detailed data will some day give to a comprehensive theory. Our knowledge of the development of three-dimensional air flow and precipitation in showers and storms should soon be much better defined by a network of Doppler radars, used with an array of other sensors.

Concepts for Tornado Modification

The discussion so far indicates that the following factors are likely to have significant roles in tornado formation and maintenance: vertical wind shear, buoyancy of rising air, background rotation, surface roughness, and cloud and precipitation de-



The solid isopleths represent velocity in meters per second (measured by Doppler radar in the direction radial to the radar system) in a section of a severe squall line over Oklahoma City at 10:21 p.m. on June 2, 1971. (The conventional radar-screen view of the same area is shown inset.) Shaded areas are those in which motion is toward the radar. Dashed lines represent streamlines which would be consistent with these observations of radial velocity. The vortex just below the center of the illustration was associated with funnel clouds. A second Doppler installation now being planned will give a second direction of wind measurement and thus more reliable estimates of total horizontal wind.

velopment. In assessing the possibilities for significant human intervention we may start on the large scale and work down.

Of course, the large-scale distributions of wind and temperature result from the atmosphere's response to solar radiance received over a wide area. Each square kilometer of the earth's surface receives more than a million kw. continuously during a dry bright midsummer day—which means that the radiance on Oklahoma alone is about 500 times greater than the total power generated by all the power plants in the United States. Although this seems to rule out active intervention by man in solar-related large-scale processes, we should note that only a small part of the solar energy is converted to energy of motion. The air's mass is about 10^{10} kg./km.^{2}, and if it moves at an average speed of 10 m./sec., its kinetic energy is 5×10^{18} ergs/km.^{2}; the wind above a square kilometer of land has an energy of about 10^{11} cal., or 10^5 kwh. If we could convert electrical energy to mechanical energy of air motion with 50 per cent efficiency, and if the cost of electrical energy were 1 cent per kwh., it would cost $200 to change the kinetic energy of a typical square-kilometer air mass by 10 per cent, or $2 million to change by a similar amount the kinetic energy over 10,000 sq. km. The latter area is about the size of the region from which low-level air is drawn by a typical major storm in which a tornado may figure as an important detail.

Among various other proposals, we may consider the use of large aircraft engines to generate or dispel updrafts. Ten engines, each capable of exhausting half a ton of air per second at a speed of 1,000 ft./sec. and a temperature of 2,000° K. (more powerful than the engines of the giant C5A airplane), would process 20,000 tons/hr., or 1/500 of the air over a square kilometer. If the exhausts were aimed vertically, after one hour the whole air mass over the square kilometer would have—if effects of mixing and the horizontal wind had not removed it—an average excess temperature of 4° C. and a vertical velocity of 2 ft./sec.

This is probably enough to trigger a meteorological event which might compete somewhat with a potentially dangerous one already established (or perhaps might become severe itself).

A related suggestion has been offered by N. I. Vul'fson of the Soviet Union; he proposes that growing convective clouds be dispersed by artificial downward currents created by flying jet aircraft through them. Vul'fson claims that during all of nine tests, clouds up to 15,000 ft. thick dispersed five minutes after such flights.

Another approach involves the controlled burning of oil or coal to produce a local hot-spot and thus controlled local convection. For each degree centigrade that we wish to raise the mean temperature of the air over a square kilometer, 250 tons of oil or 375 tons of coal are required. Such quantities of fuel are indeed burned in forest fires and in brush and land clearing operations, and large clouds are often observed to form as a result. Henri Dessens of France considered such techniques for many years and developed an experimental apparatus, the Meteotron, to stimulate rainfall. Under particularly favorable conditions it produced towering clouds, but the cost of operation was great and the final results uncertain.

Tornadoes would be reduced or prevented if their parent thunderstorms were reduced or eliminated. Since such storms require that potential temperatures be relatively high near the ground, this would be accomplished if the atmosphere's mid-layers were sufficiently heated, or the surface layers cooled. Suppose that we could eliminate tornadoes at a particular time by raising the temperature by one degree centigrade in a middle layer comprising 25 per cent of the mass of air over a particular 10-km. square. The energy required would be about 6×10^{13} cal. or about 80 million kwh.

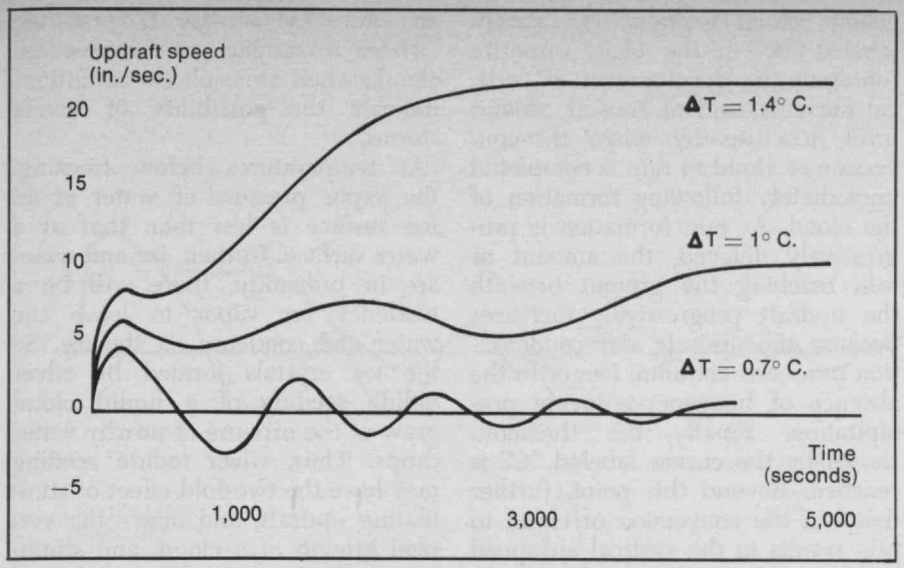
Obviously, the present cost of significant thermal perturbation of the atmosphere by direct methods greatly exceeds the damage losses attributed to most tornadoes. We have admittedly only considered the treatment of air masses as a whole, not the nature and cost of a more specific system to identify and affect critical details of an air system. But neither, at this stage of our knowledge, do we really know just what changes would be necessary to prevent tornado formation. But in any event, the analysis indicates a prohibitive cost for routinely and significantly modifying the atmosphere's kinetic or thermal energy by an input of energy from man-made sources.

Thus, our ultimate ability to exercise appreciable control over storm phenomena will probably depend on our ability to influence the distribution and effects of natural energies. We now know of several possible techniques which would have energy budgets of the necessary size, although at present our general meteorological understanding, ability to sense relevant conditions, and ability to respond in timely fashion to them, all fall far short of what will be required to induce beneficial modifications to severe storms. We will also need to know how to preserve beneficial rains while we reduce a storm's damaging features.

Three Approaches to Modification

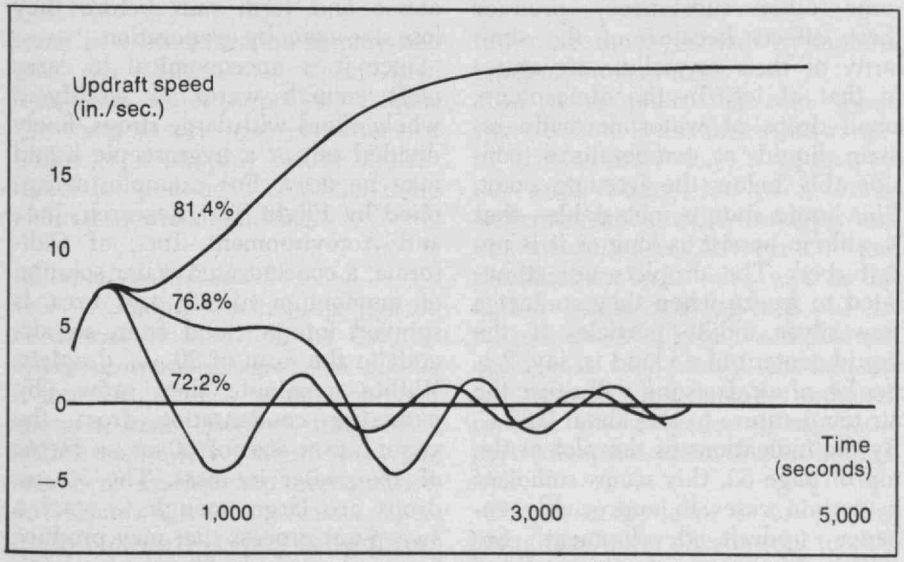
We recognize at least three potentially practical approaches to the manipulation of nature's energy. One involves alteration of the effective solar radiant input (which on a daily basis is about enough to raise the temperature through the whole depth of the atmosphere by 3° C.). It seems that, from place to place in the surface layer, variations of several degrees in temperature and several per cent in relative humidity could be induced artificially by changing the characteristics of the surface, such as the albedo and the availability of water for evaporation. Indeed, Bruce Atkinson in England and Stanley Changnon and his associates in the United States are finding evidence that man's building and engineering activities may be inadvertently increasing the incidence of summer thunderstorms and showers over cities.

The second approach involves modification of the flow of wind close to the earth's surface (which, as far as the meteorologist is concerned, is the atmosphere's very influential lower boundary). This would be particularly attractive if, for example, tornado suppression by wind reduction could be combined with a technique for converting atmospheric kinetic energy to usable electricity. Wind reduction is a conceivable strategy, in the light of the probable dual role of the boundary layer in tornado development. (On the one hand, boundary friction reduces spin, thus allowing surface air to converge to smaller radii than



A numerical model distinguished these three modes of updraft, initiated by temperature perturbations of different strengths (ΔT) in a "conditionally unstable" atmosphere. Weak disturbances (such that no significant condensation of water occurs) result in damped gravitational oscillations, and finally zero updraft. A stronger disturbance leads to damped condensation oscillations (the updraft is moderated by the rainfall it induces); the updraft continues, with rain beneath. A very strong perturbation produces a high-speed sustained updraft, with rain falling outside the updraft column (because, within the column, air is rising faster than rain can fall through it).

centrifugal force would otherwise permit; on the other hand, when the friction is sufficiently large there should be a reduction of net low-level inflow and thus a reduction in the rate of the convergence so vital to the maintenance of spin. Indeed, large values of surface friction may be a reason for the rarity of tornadoes in mountainous terrain.) Thus, an array of large windmills such as may some day be erected for nonpolluting power generation—an idea recently reconsidered by Karl Bergey of the University of Oklahoma School of Aerospace, Mechanical and Nuclear Engineering—might be made to serve the secondary purpose of reducing the kinetic energy of storms. But even without such utilization of wind power, we may learn how to alter the earth's topography and roughness so as to decrease the probability of tornadoes over inhabited areas—perhaps by building special-purpose mounds and ridges or by planting wind-resisting vegetation.



The latent heat released by condensing water vapor is a critical ingredient in sustained convection. These curves, again from the numerical model, illustrate differences in the updraft behavior that follows the same initiating disturbance when the humidity at the ground varies only between 72 and 81 per cent.

A third approach involves the alteration of precipitation processes. In connection with this and the preceding ideas, some illustrations using a simple numerical atmospheric model may be of interest.

A Numerical Model of Convection

The shower model we have developed at N.S.S.L. treats the very small water particles (those of clouds) as sharing the motion of the air in all respects, while the larger (precipitation) particles share the air's horizontal motion but not its vertical motion. As cloud water changes to precipitation, it starts to fall relative to the air. The effects may be to alter the net burden of condensation products borne by the air, the air's effective buoyancy, and/or the updraft speed. Equations have been formulated to describe the relative motions of water and air, the changes from cloud to precipitation, the sweeping-out of cloud by large precipitation particles, the evaporation of precipitation and cloud in unsaturated air, and the mixing of cloud and precipitation with surrounding air. An equation of motion describes vertical acceleration in terms of buoyancy, and another accounts for the creation of buoyancy following the vertical movement of air in an environment of specified moisture content and temperature. The various parts of the numerical scheme are intricately interwoven with one another, but several prominent effects are readily identified and understood.

For example, the illustration at the top of this page shows how the evolution of an atmospheric disturbance (represented here in terms only of vertical velocity) may be affected by the intensity of an initiating thermal perturbation. At the start, the model atmosphere is unsaturated, so there is no condensed water. It is stable toward vertical displacements that do not result in condensation but unstable toward vertical displacements that do (a very common state known as conditional instability). An initial thermal buoyancy of 0.7° C. results, in the model, in a gravitational oscillation: the starting perturbation is not strong enough to produce the vertical displacement of air required to initiate condensation, and the air speed eventually returns to zero. With a starting perturbation of 1° C., condensation and precipitation result before the vertical air

speed becomes large. The accumulation of precipitation in the updraft column then offsets the thermal component of its buoyancy and prevents it from becoming very strong. Damped "condensation oscillations" follow, ending in a steady updraft of moderate speed with heavy precipitation at the ground beneath it. There is a definite range of initial temperature perturbations that produce this type of consequence.

The third type of outcome occurs when the starting perturbation is strong enough so that the speed of the updraft reaches and exceeds the fall speed of precipitation before a significant amount of precipitation forms in the rising air. In this case, rain can fall no further than the base of the clouds wherein it forms. Thus it cannot re-evaporate in the drier air beneath the cloud (where, in the second case, it effectively reduces buoyancy). Instead, precipitation is carried rapidly to high levels, where it is spread out by horizontally dierging winds. Though there is no precipitation beneath the updraft column in this case, the rain that survives evaporation may reach the ground elsewhere. Because the weight of condensation products in the updraft column is much less in this third case than in the second, the updraft speed is much faster. Presumably, this situation would be most likely to have tornadoes associated with it. As previously indicated, the required near-surface temperature differences (of the order of a degree, in the model) may arise in the real atmosphere from natural or artificially induced variations in the albedo of the earth's surface.

A second characteristic of the atmosphere is simulated by the plots at the bottom of page 53. As already noted, the heat latent in water vapor is critical in relation to the atmosphere's stability toward overturning. The curves show the evolution of an atmospheric disturbance for different values of the relative humidity at the earth's surface. Unfortunately for our research, the differences of humidity depicted—which appear from the model to be important and which can perhaps be induced locally by artificial means—are of about the same order as the errors in modern observational data.

The third set of numerical results illustrates a possible effect of the microphysical processes which change cloud to rain. The curves labeled "A" in the chart opposite represent the development of vertical currents, and of rain at ground level, in a situation where the conversion of cloud to rain is completed immediately following formation of the cloud. As rain formation is progressively delayed, the amount of rain reaching the ground beneath the updraft progressively increases because the updraft and condensation processes continue longer in the absence of buoyancy-reducing precipitation. Finally the threshold shown by the curves labeled "C" is reached. Beyond this point, further delay in the conversion of cloud to rain results in the vertical air speed reaching values great enough to prevent the rain from descending below the cloud base, and subsequent updraft development abruptly shifts to the form shown by curve D—a high-speed updraft case which might be identified with a relatively high frequency of tornadoes.

Some Plausible Precipitation-Modifying Techniques

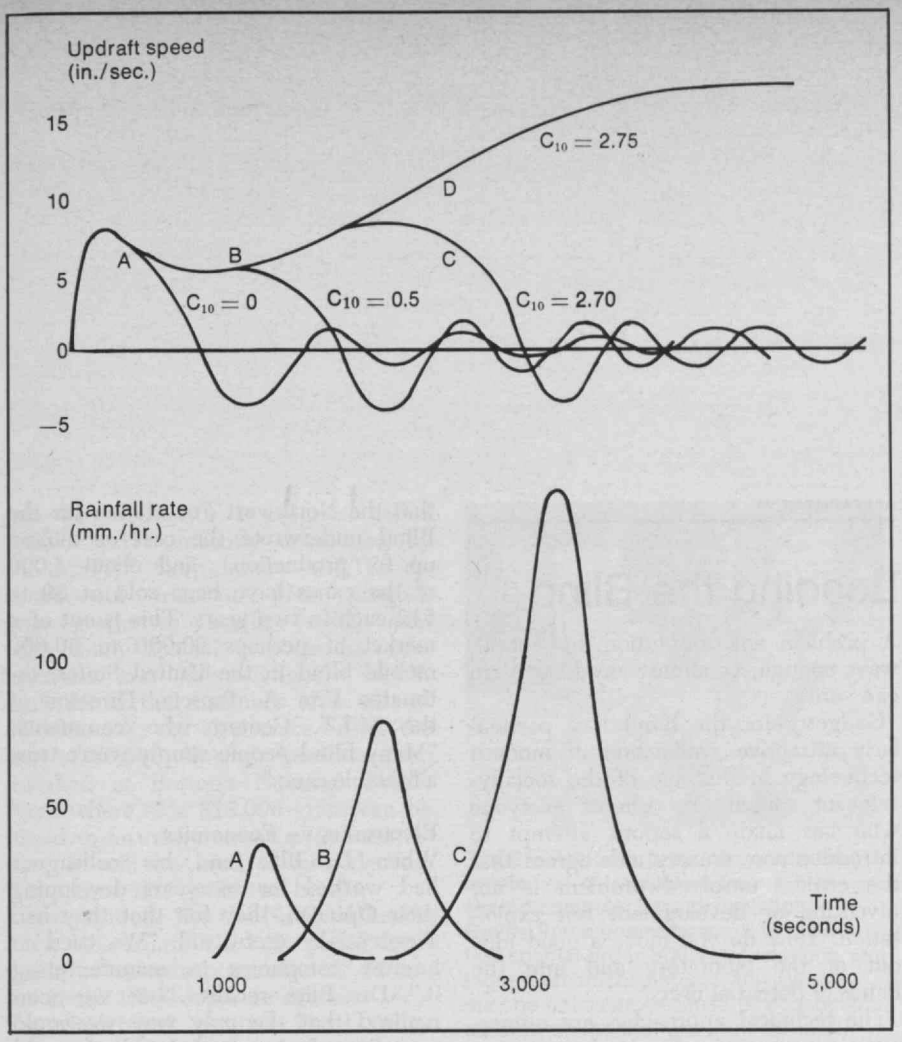
A significant part of the energy budget of a storm system is the latent heat released when water or water vapor turns to ice at high altitudes. Techniques are available for altering this freezing process. Not only can a pound or so of silver iodide induce a temperature change that is equivalent (under ideal conditions) to the burning of a thousand tons of coal, but the rate of precipitation from cloud can also be altered with this substance. Silver iodide (and some other substances) produce these effects because of the similarity of their crystalline structures to that of ice. In the atmosphere, small drops of water normally remain liquid at temperatures considerably below the freezing point. This liquid state is metastable—that is, able to persist as long as it is undisturbed. The droplets are stimulated to freeze when they contact a tiny silver iodide particle. If the liquid content of a cloud is, say, 2 g. per kg. of air, freezing will cause the air temperature to rise about 0.6° C. By the indications of the plot at the top of page 53, this seems sufficient in certain cases to appreciably enhance updraft development. So-called "dynamic cloud seeding," based on this concept, is currently being practiced in Florida by Joanne Simpson and William Woodley in an effort to increase the rainfall. (These investigators avoid seeding clouds when atmospheric conditions indicate the possibility of severe storms.)

At temperatures below freezing, the vapor pressure of water at an ice surface is less than that at a water surface. If, then, ice and water are in proximity, there will be a tendency for vapor to leave the water and condense on the ice. So the ice crystals formed by silver iodide seeding of a liquid cloud grow at the expense of nearby water drops. Thus, silver iodide seeding may have the two-fold effect of stimulating updraft, and hence the vertical growth of a cloud, and stimulating the growth of particles to precipitable size.

In warm clouds, other substances may be used to stimulate (or to inhibit) the conversion of cloud to precipitation. In terms of our numerical model, stimulation of raindrop formation might lead to a shift in updraft regime from the D curve in the chart on page 55 to the C curves, or from C to B, with a reduction of storm intensity, and perhaps an alteration of local rainfall as well.

As a practical example, large water drops may be sprayed into a cloud and by their sweep-out of small drops start a chain reaction: droplets grow and multiply by breakup at a certain size; and each new drop undergoes the same growth cycle, culminating in conversion of the entire cloud to precipitation. This can be done even when the naturally occurring drops are too small to coalesce and form rain before they lose size again by evaporation.

Since it is uneconomical to carry aloft enough water to modify a whole cloud with large drops, finely divided salt or a hygroscopic liquid may be used. For example, as applied by Flight Test Research, Inc., and Aerovironment, Inc., of California, a concentrated water solution of ammonium nitrate and urea is sprayed into a cloud from an aircraft in the form of 20-μm. droplets. Within a minute they grow (by gathering condensation from the vapor) to a size of 50μm., a factor of 15 greater in mass. The 50-μm. drops are large enough to start a sweep-out process that may produce 5-mm. drops only 20 minutes later. (A 2-mm. raindrop whose mass includes one of the originating spray drops will contain the seeding ma-



Here the numerical model shows the effects of cloud seeding on updraft (above) and precipitation (below). Seeding alters the threshold cloud density C_{10}, expressed in gm./m.^{3} of water, at which cloud droplets begin to convert into precipitation. In curve A, conversion to rain starts as soon as the cloud forms, resulting in early reduction of updraft buoyancy due to evaporation of rainfall in the rising air below the cloud; in curve D, the threshold is a water density of 2.75 g./m.^{3} or more, and the updraft grows strong enough so that the rain falls outside it. Note the abruptness of the transition to this condition from condition C, where the critical water density is only a little less.

terial in a concentration of only one part per million—far purer than municipal water supplies.) Under the theoretically best conditions, a gallon or so of spray would be adequate for treating a cloud covering about a square kilometer.

Alternatives to Control

Our reasoning, backed up by the numerical models, tells us that by applying seeding agents to clouds it may be possible to alter thermal energies and effective buoyancies sufficiently to affect significantly the course of updraft and precipitation development. And man-made lakes, asphalt paving, cooling towers, and plumes of dust many miles long are producing local variations in the air's thermal and hygrometric properties approaching the same magnitudes as those caused by natural topographic features.

But it is plain that our atmospheric models are much too simple to give us more than a glimpse of the multi-faceted life of a storm, and that much more research and improvement in observation and modification techniques will be required before we can use our resources effectively to channel storm energies in such a way that benefits are increased and damages reduced. Indeed, the evidence is not now persuasive that this will ever be possible.

This naturally leads us to consider thoughtfully the alternatives to control. We may note here some simple, practical remedies that could be put into practice immediately. For example, damage can in a large number of cases be traced to remediable structural weaknesses. Damage surveys frequently show that the homes destroyed in a given community are those not well bolted to their foundations or evidencing easily collapsible construction of corners and roofs. Trailer homes are often overturned and broken in winds of no more than 100-125 kn., or even less. The improvement and strict enforcement of building codes, and the use of cable anchorages to prevent the overturning of trailer homes, are examples of important steps that can be taken at little cost toward a marked reduction of losses.

Of course, even the best built home will not resist the occasional extremely severe tornado, and the way to prepare for these cases is to build storm shelters and obtain adequate insurance. In homes without shelters, occupants should select in advance a small enclosed space, such as a bathroom, for use as a retreat during a tornado emergency.

During the next decade, we can expect the development of significantly improved techniques for storm identification and warning using data from radars and artificial satellites. The provision and effective use of timely advisories to those in threatened areas should lead to acceptably low mortality and injury rates from destructive storms.

Suggested Readings

Stanley A. Changnon, Jr., Floyd A. Huff and Richard G. Semonin, "METROMEX: An Investigation of Inadvertent Weather Modification," *Bulletin of the American Meteorological Society*, Vol. 52, No. 10. pp. 958-967.

Edwin Kessler, "Tornadoes", *Bull. Am. Met. Soc.*, Vol. 51, No. 10, pp. 926-936.

Edwin Kessler and William C. Bumgarner, "Model of Precipitation and Vertical Air Currents," National Severe Storms Laboratory *Technical Memo* No. 54.

Frederick Sanders, "Toward Defining Human Needs: How Does the Atmosphere Hurt Us?" *Bull. Am. Met. Soc.*, Vol. 52, No. 6, pp. 446-449.

J. Simpson and W. L. Woodley, "Seeding Cumulus in Florida: New 1970 Results," *Science*, Vol. 172, No. 3979, pp. 117-126.

Neil B. Ward, "The Exploration of Certain Features of Tornado Dynamics Using a Laboratory Model," N.S.S.L. *Tech. Memo* No. 52.

Trend of Affairs

Trends This Month

ASSESSMENT

Sensory aids: much development, little impact . . . Black engineers and the needs of black people . . . A marital myth for technological man.

INTERNATIONAL

In world food supplies, dramatic growth is the exception . . . and is bad news for some . . . A developing China faces its old antagonist.

ECONOMICS

Fair shares of a limited coastline . . . Man's needs are not in the textbooks.

EDUCATION

Why so few women physicists? . . . As the cutbacks began, some kinds of engineers were hard to find . . . The fossilizing effect of constrained university budgets . . . Artists and scientists both are craftsmen.

ENERGY

Urban refuse as a national fuel . . . Energy wastage in buildings: faults we could correct . . . are copied by poorer nations.

SOCIETY

Engineering for human situations—a discipline nobody teaches . . . The Japanese tackle a housing shortage and abandon a way of life.

ASSESSMENT

Leading the Blind

A problem and a solution are not always enough, as almost any blind man can verify.

Gadgetry for the blind is a particularly attractive application of modern technology in this age of the socially-relevant spinoff. Yet almost everyone who has made a serious attempt to introduce new sensory aids agrees that the critical unsolved problem is not invention or development but exploitation: How do you move a good idea out of the laboratory and into the hands of potential users?

The technical approaches are numerous. A group in England is trying direct replacement of the defective sensory function by translating the output of a portable television camera into a two-dimensional tactile image on the abdomen. Dr. Leslie Kay, a New Zealander now working at Boston College, is conducting extensive evaluation trials of a bi-directional ultrasonic sonar system mounted in a pair of spectacles. The output is audible sound, one channel for each ear.

M.I.T.'s Center for Sensory Aids Evaluation and Development has built a television-based reading aid for those who can still read very large images; it is now being evaluated by the Massachusetts Commission for the Blind. And a group of Stanford researchers, headed by Dr. James C. Bliss, recently formed a company to manufacture the "Optacon," a device which translates optical images from a hand-held probe, passed over a printed page, into a mechanical image of raised pins.

But despite the years of effort, only one new device is actually in use by large numbers of blind people. It is but an improved version of the traditional long white cane: a cane designed at M.I.T. to be light and rigid but conveniently foldable when not in use. The Institute's Center found a company to manufacture it (provided that the Northwest Foundation for the Blind underwrote the cost of tooling up for production), and about 4,000 of the canes have been sold at $9 to $12 each in two years. This is out of a market of perhaps 30,000 to 50,000 mobile blind in the United States, estimates Vito A. Proscia, Director of the M.I.T. Center, who comments: "Many blind people simply won't trust a foldable cane."

Electronics vs. Economics

When Dr. Bliss and his colleagues had worked for six years developing their Optacon, they felt that they had a potentially useful aid. "We tried to interest companies in manufacturing it," Dr. Bliss recalls, "but we soon realized that the only way we could get it into the hands of the blind would be to build it ourselves." It is too early to tell how many people will be able to use the $5,000 device, for production—initially of about 10 per month—began only last September.

Dr. Kay feels that the keys to successful introduction of his ultrasonic spectacles will be federal money and thorough training of users. But, according to M.I.T.'s Robert W. Mann, Germeshausen Professor in the Department of Mechanical Engineering, federal support on that scale is simply not available. In fact, he reports, the total federal support for research and development of sensory prostheses is only about $2 to $3 million per year, "and a lot of that gets piddled away on useless stuff."

Professor Mann and his colleagues have been involved in the groping progress of sensory aids research for more than a decade; so it was with great hopes but the caution of experience that they unveiled another new device in February. The product of about ten years' work, the Braillemboss takes its input from a computer and produces high-quality braille. It can be used by a blind programmer to communicate with a time-shared computer, it can prepare braille texts of any computer-based information, or it

can be used with a program called DOTSYS III—recently developed by the MITRE Corp. under M.I.T.'s direction—to translate plain English into "grade-two" braille (which contains many special symbols for contractions and abbreviations). M.I.T. built 20 of the machines at a cost of $5,000 each; the electronics brings the cost to $6,500. One of them has been installed at Boston's National Braille Press where, if a $15,000 grant can be found to finance a one-year demonstration, it will be used to provide fast translations into grade-two braille.

Organizations like the National Braille Press coordinate the efforts of hundreds of volunteer translators. (There are about 1,000 separate agencies serving the blind in the U.S.) They are run very cheaply as charitable institutions, but their service is notoriously slow on special-order translations. Louis S. Dennis, Director of the National Braille Press, believes enthusiastically that the Braillemboss will be a boon to the professional blind who need special documents translated quickly. Professor Mann believes that technical professionals, in particular, will benefit, for the volunteer translators tend to dislike mathematics.

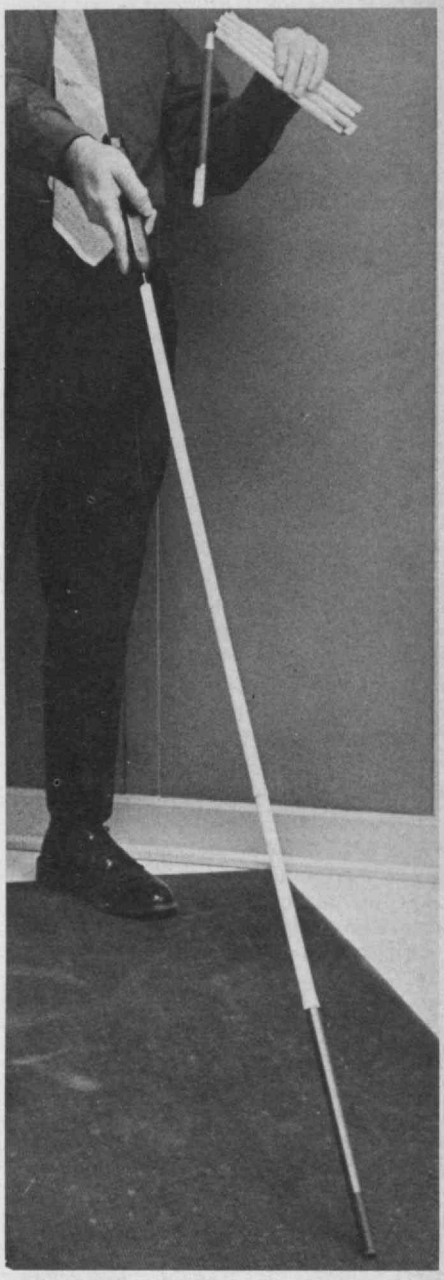
Though $6,500 may seem a small price for such a useful service, to the National Braille Press "it is a fairly sizeable investment, no matter how you look at it," Mr. Dennis said. Mrs. Jennie Beck, of Philadelphia's Volunteer Services for the Blind, said the cost "may be prohibitive."

Mrs. Florence Grannis of the Iowa Commission for the Blind fears a different problem: demoralization of the corps of volunteers who now do the same job manually. But Mr. Dennis believes there will be no problem; the recreational reader and the general reader who knows in advance what he will need will still rely on the volunteers.

And blind people will continue to rely, for the immediate future at least, on their canes, dogs, and volunteer helpers. The barrier to twentieth-century technology is fragmented nineteenth-century organization. But though regrettably inconsistent, the old system usually manages to deliver nineteenth-century aids at a remarkably low cost.—*R.A.*

The Braillemboss produces grade-two braille text on command from a time-shared computer. Boston's National Braille Press hopes to use it to provide fast special-order braille translations. But though technically sound, the system may be unusable because of economic considerations that are intrinsic to our charity-based system of services for the blind.

The Optacon translates the printed images under a hand-held probe into a mechanical image of raised pins. Its developers found that the market is so uncertain that no firm would risk putting it into production—so they had to form their own company to build it. (Photo: Wide World Photos)



After years of technical brainstorming, the only new sensory aid to find its way out of the laboratory and into the hands of thousands of blind users is an improved version of the traditional long white cane. The difference is that this one folds.

Black View of the Uses of Technology

Though the misuses of technology, actual and alleged, present and potential, occupied much of the discussion, a midwinter intercollegiate "Black Experience in Science and Technology" at M.I.T. suggested how these apparently universal concerns have special force for minorities.

As a starting point, black Americans find themselves in a society where technological change not only is out of their control but—as many see it—presently works against them. This view has been detailed in *The Choice, The Issue of Black Survival in America,* by Samuel F. Yette, professor of Journalism at Howard University and former staff member of *Newsweek* (he has filed charges of racial discrimination in connection with his dismissal). Professor Yette, the opening speaker at the conference, set off a familiar enough debate on the—still unsolved—question of the responsibility of the researcher in relation to the uses to which his work is put.

The conference consisted mainly of four workshop sessions, running concurrently: communications, economic development, health care, and transportation. On the first of these, a major talking point was cable TV, of interest both because of the promise of community-run local channels and because the potential uses of two-way facilities (now required in some form by the Federal Communications Commission) seem to call for "eternal vigilance." At that time, President Nixon had not yet announced his choice for a black member of the Federal Communications Commission (Benjamin L. Hooks, a lawyer and minister). The conference expressed support for a Washington communications consultant, Theodore Ledbetter, Jr. who took an active part in the conference and emphasized that such an appointee should be technically qualified.

Although the main emphasis was on the technical needs of American cities, there was some discussion of the possibilities for "technological partnership between (black) America and Africa." Some of the work that needs to be done was outlined by a civil engineer from West Cameroon, now at M.I.T., Robert E. Efimba: There are basic tasks in communications (many African countries are still in better telephone contact with Europe than with their neighbors), highways (again, inter-state links are lacking), and low-cost building (not only of houses—a middle-class African who travels often finds the European-style hotels far beyond his means). There is a need to gather basic engineering data in anticipation of construction projects: Mr. Efimba has found his work in Africa hampered by the absence of, for example, hydrologic data which would be readily available in an advanced country.

He stressed that, in undertaking engineering tasks in Africa, it is not enough to simply apply American or European codes and design habits. To do good and inexpensive work, one must understand local conditions and the possibilities of local materials, and he must think from basic principles. Of course, he said, any good engineer knows this, but there is still the tendency to impose solutions learned abroad rather than truly solving local problems.—*F.W.*

Three Brothers Woo High Technology

Once upon a time there were three brothers, each of whom decided to court the only daughter of a wealthy landowner.

The eldest brother came home shaking his head: the girl, he said, was not what she seemed; her skin was blemished and she spoke with a stutter.

The middle brother, undeterred, returned from his first visit in rapture—and for the next weeks the brothers' home resounded with the young lady's praises. But gradually the middle brother's ardor cooled: the lady spent too much time fussing over her person, and she was—for one so wise—sadly uninformed.

So the younger brother promptly made his call on the young lady, and soon after they were married. He sent her to a dermatologist for her skin, hung only two mirrors in his house, required her daily to read the *New York Times,* and considered her slight stammer an indispensable part of her very great charm.

The beautiful maiden in this story—which comes from a paper describing the Tulane University Program on Science, Technology, and Man, by its Co-Directors, Jane C. Keller and George R. Webb—is high technology. The eldest brother stands for those who fill scholarly journals with articles about how the world's problems may be laid at technology's door, that "man is speeding the coming of an eternal night through his use of the infernal technological megamachine."

The middle brother represents those convinced that, "through technology, man's age-old yearning for a utopian condition for the human race will soon be fulfilled." When his vision fails, the middle brother joins his elder in prophecying doom.

The younger brother is the pragmatist who would use technology as it stands, making it perform for the proper ends of mankind.

The authors identify with this pragmatic view: "Technology is neither evil nor good; it is a tool or system of tools that men must use with deliberate care to achieve a human good." But some of the pragmatists make a fatal mistake: they overlook "the complex interaction between man and his technological constructs." In the quest for control over his surroundings, and for greater predictability in the varying contingencies that affect his life, man tends to bring about situations in which he too is somewhat controlled—somewhat predictable.—*J.M.*

INTERNATIONAL

It's Not Yet a Green Revolution

The 1971 report of the United Nations Food and Agriculture Organization makes two points clear: the world has not really increased its per capita growth of food in the last decade, and to do so in the future—perhaps just to stand still—will require thorough international planning and cooperation.

The Far East now grows twice as much wheat as it did five years ago: but that is the only impressive gain. (A startling one was Cuba's 1970 sugar harvest—80 per cent higher than in 1969—but sugar is not a major food.) Pakistan imported 2.4 million tons of wheat in 1967; in 1970, only 0.6 million. In India, the corresponding figures were 6.3 million and 3.4 million tons; India now has a reserve wheat stock of 6 million tons. (The United States carries a stock of 24.1 million tons of wheat, Canada 27.5 million tons. The world harvest both in 1969 and in 1970 was 287 million tons.)

"But," as F.A.O.'s Director-General A. H. Boerma, comments in his foreword, "This is not yet a green revolution." The Far East has not similarly raised its output of legumes, livestock, other cereals, and vegetable oils, the report continues. But then, neither has the rest of the world. Less maize, by 3 per cent, was grown in 1970 than 1969 (partly because of the corn leaf blight in the U.S.). Production of barley, millet, and sorghum remained the same. Meat production was up 4 per cent: sugar was up 10 per cent (because of the Cubans.) The harvest of fish grew slightly.

"There was little or no increase," writes the Director-General, "in the developing countries in Africa and the Near East, so that in per caput terms their food production fell. In Latin America output grew more, but even there it was just sufficient to keep pace with population growth."

Population increased by 2.4 to 3.0 per

	Calories	Total protein (in grams)	Animal protein (in grams)
India	1940	47.9	5.6
Mauritius	2210	45.5	11.9
United States	3290	96.8	69.5
Hungary	3180	97.4	42.2
West Germany	2940	82.2	53.9
Norway	2900	81.7	51.4
U.S.S.R.	3180	92.2	35.8
Canada	3150	96.8	66.1
Brazil	2546	63.0	21.8
Peru	2200	52.4	18.4
Japan	2450	75.1	29.7
Pakistan	2350	53.5	10.0
South Africa	2730	77.0	28.3

The average daily intakes of food are shown above for several nations, developed and undeveloped. The Food and Agriculture Organization expresses concern over the low protein intakes, and sometimes the low calorie intakes as well, in some regions. The F.A.O.'s 1971 report shows how little improvement has occurred in the production of enough food of the right kinds to rectify the diets of those in developing nations. Grams of animal protein are tabulated because vegetable protein is often incomplete and not as useful to the body. All data are for 1969 except that from the U.S.S.R. and South Africa; their data span 1964 to 1966.

cent per year during the decade; overall, the world's food production increased by about 4 per cent, but the large gains were in the developed countries.

Among the developing regions, only the Far East, because of its wheat and rice crops, showed a greater growth in food production—7 per cent more than in 1969—than in population—2.5 per cent more. The F.A.O. hopes for an increase in food production overall in the developing nations of 4 per cent per year, and for a greater one for protein.

The report also compares the intake of total calories and of protein in different regions of the world (see the table above): the measure of animal protein is important as vegetable proteins are often incomplete and not as useful to the body. The National Research Council of the National Academy of Sciences sets 70 gm. of protein per day as a minimum daily requirement.—*J.K.*

. . . But It Could Be

The selling of food and fiber has become steadily more important in world trade, but in 1970 for the first time the increase in value of these goods since the previous year—14 per cent—matched that of other commodities, the F.A.O. report continued (*see above*). Ten per cent more agricultural products were traded, which accounted for most of the rise; the price per unit increased about 3 per cent. Most of the benefits went to North America—the value of its agricultural exports grew by 28 per cent. Western Europe's increased by 14 per cent: Australia's and New Zealand's together, by 6 per cent. But the developing regions increased the value of their exports also: Latin America by 11 per cent and Africa by 17 per cent. The Near and Far East did less well.

Commerce in agricultural produce is still an uncertain business. The value of individual crops as well as a nation's whole set of exports can fluctuate wildly from one year to the next: North America's 28 per cent gain, for instance, followed two years of decreases. Those countries who count on agriculture more heavily for trade dollars, of course, are more vulnerable.

The rice story shows what can happen: For several years, the world has concentrated on growing more cereal crops, specifically wheat and rice, of which new, more productive varieties have become available. Rice and wheat are now surplus foods on the world market. (Individual countries still have shortages.) Rice cost 17 per cent less per unit in 1970 than in 1969, although a greater quantity was traded. Because the developed nations made large shipments on concessional terms, the report says, they managed to export 16 per cent more rice than the previous year; the developing nations shipped only 2 per cent more. For some nations the inequality was especially painful: Dr. Boerma, in his foreword, cites the Thai rice farmer as particularly hurt by the sudden self-sufficiency of his neighbors.

Because of such changes, Dr. Boerma continues, nations must begin to plan their agriculture together, on a worldwide basis, not a national or even regional one: ". . . the completely unbalanced state of world agriculture . . . would, if allowed to persist, slow down world development and might even provoke intensified trade war and destroy patterns of cooperation built up so painfully since 1947." He proposes that the 1973 conference of the F.A.O. consider how such international adjustments might be made. For he sees protectionism rising already—the farmers of the developed nations are no more willing than the Thai farmer to absorb such radical changes in their markets. And agriculture, the report says, "has clearly failed to benefit" from the general movement toward reducing tariffs among nations since World War II.

The report restates the hope for the United Nations' Second Development Decade—that each developed nation will contribute by 1975 0.7 per cent of its G.N.P. in "official development assistance," and that its annual net transfer of resources will total 1.0 per cent of its G.N.P. by 1972.—*J.K.*

The Real Meaning(s) of Nixon in China

Richard M. Nixon's trip to China was not one but two missions—one political, one profoundly historical, says Lucian W. Pye, Professor of Political Science at M.I.T., in a copyrighted article in M.I.T.'s undergraduate newspaper, *The Tech*.

Domestic political affairs in both countries obviously suggested the visit. No one doubts its importance to Mr. Nixon in an election year. Less obvious, writes Professor Pye, was Chou En-lai's "urgent need" to "consolidate his position as the operating leader of China and heir-apparent after Mao Tse-tung. . . . Nearly two-thirds of the Politburo and over 200 senior military officials have been eliminated" in a power struggle which began about the time of Henry Kissinger's first visit to China.

One of the ostensibly larger issues in the communique released as President Nixon left China turns out to be of little significance. The withdrawal of U.S. forces from Taiwan to which Mr. Nixon agreed probably refers to some 6,000 Air Force personnel whose duties are related to Air Force operations in Vietnam, not at all to the defense of Taiwan. The 2,000 U.S. personnel working with the Nationalist forces are not necessarily affected, since such people are not usually regarded as "combat forces."

Chou's earlier hints that the Chinese might forego using force in seeking to "liberate" Taiwan, and accept the American defense treaty with the Nationalists, had opened the way for Nixon's visit.

But for Chou En-lai, writes Professor Pye, the U.S. acknowledgment that Taiwan is a part of China had "paramount importance." It meant that both the U.S. and China were arrayed against those on Taiwan who denounce Chiang Kai-shek and seek independence for that island.

Renouncing the Taiwan independence movement was simply "the price the U.S. had to pay for . . . getting on with other aspects of U.S.-China relations."

The importance of this agreement for China is that she needs to avoid diversionary threats during her "massive, state-to-state military confrontation with the Soviet Union." Indeed, writes Professor Pye, "in spite of the drama attending developments in Sino-American relations, it is Sino-Soviet relations which are now the most dynamically unstable and critical for Asia, if not for the world.

"The great question for the next decade is how the Soviet Union will conduct itself as it has to experience with China what the U.S. in the last two decades experienced with the Soviet Union. . . . For now it is the Soviet Union's turn to have to watch an enemy seek to assert itself as a nuclear power." And this time, writes Professor Pye, "there is a much more sensitive interrelationship (than in the case of U.S. and Russia) between the strategic balance, tactical deployments, and political antagonisms.—*J.M.*

ECONOMICS

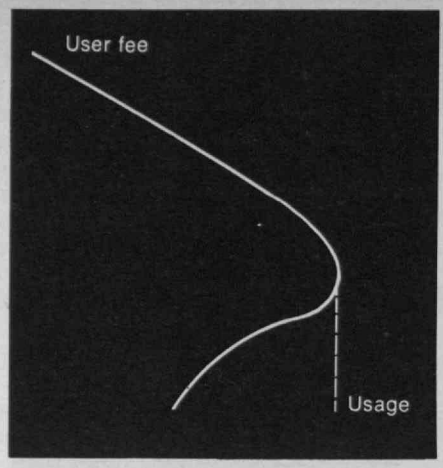
Coastline: Private Or Public Good?

The free-enterprise market system (the idea that prices take their level on the basis of supply and demand) is leading the country to a crisis in seashore resources, says Dennis W. Ducsik, an M.I.T. graduate student.

The problem is that the private market system implies that those who cannot—or will not—pay for a product must be denied its use. But this principle is simply not applicable to coastline, which is now in such short supply that it is no longer possible or in the public interest to restrict access to buyers.

So we must now consider the shoreline as a "public good," writes Mr. Ducsik. "It has an intrinsic value to society as a recreational resource, in that everyone in a democracy has an inalienable right to derive equal benefit from the value of shoreline recreation . . ."

If not by private market, then how do we set priorities for shoreline land uses and values? The responsibility obviously lies with government, but there is no obviously correct answer. In one



Are user fees a good way to apply supply-and-demand market characteristics to a recreational park? Not necessarily, says W. Robert Patterson, an M.I.T. graduate student, in a land-use report prepared for the Senate Committee on Interior and Insular Affairs last year. Fees can be set to support whatever policy is desired: very high, to discourage use; at some medium point to encourage highest possible use (dashed line); or at some point (not described on the chart) to maximize cash income. The issue would be far more complex, writes Mr. Patterson, if the toll related to a system of recreational resources instead of to a single park.

of a series of papers on land-use policy prepared for the Senate Committee on Interior and Insular Affairs late last year by M.I.T., Boston University, and Woods Hole Oceanographic Institution students in a seminar conducted by Carroll L. Wilson, Professor of Management at M.I.T., Mr. Ducsik offers this proposal:

☐ Let the states make master plans for their own coastline resources that take into account as best they can local, regional, and national interests and the competing needs of industry, conservation, and recreation (among others).

☐ Let the federal government set guidelines to ensure that each state's plan is compatible with those of its neighbors, and to show states how to make decisions when they encounter conflicts in costs and benefits.

Though most shoreline laws now under consideration are consistent with his proposal for states' responsibilities, Mr. Ducsik says all are "seriously deficient" in failing to provide for strong federal involvement.—*J.M.*

Homo Economicus Meets the Trinity

Is it true that the greatest problems confronting us today are the "unholy trinity"—pollution, congestion, and depletion of natural resources? Not at all, Lester Thurow, Professor of Economics at M.I.T., told the M.I.T. Alumni Advisory Council this winter.

Pollution can be solved by merely internalizing the costs: "We just have to get used to the idea that pollution is expensive." Once the shift is made, pollution control can be accomplished within the framework of the present economic system.

And as for congestion, Professor Thurow said, it appears that we have already reached zero population growth in the United States, "so let's think now about how we can rearrange the people we have."

And depletion of natural resources is an illusory problem, he said, because one of the greatest strengths of our economic system is rationing natural resources. Whenever a resource becomes scarce, it becomes too expensive to continue exploiting it.

So, although it has been proposed that the solutions to the trinity of problems are zero population growth and zero economic growth, the former has already been accomplished and the latter should be replaced with a policy of "high-quality economic growth, balancing what we want against what we don't want."

Economists have tried to view society as composed of "economic men" who behave according to the laws of economics, he continued. This *Homo economicus* is supposed to be a "want-processing machine" which tries to maximize its benefits according to its innate wants, within economic constraints. But this model fails because man's wants are not innate. Our main economic goal, Professor Thurow said, should be to define the fundamental wants of man.

Until 1955, he explained, the average American work week had been steadily declining; but since then it has held constant. He put forward two hypotheses to explain this anomalous behavior: we have developed a taste for capital-intensive leisure; we would rather spend a week in a motorboat than a month in a canoe. And the widely accepted assumption of the disutility of work ("an economist's way of saying, 'I hate my job' ") does not always hold.

The group who have made the most dramatic gain in leisure time in the past few years are housewives—and they, too, are showing a strong tendency to spend their new leisure time in gainful employment. The only man who is a true *Homo economicus* is the assembly-line worker who does, indeed, hate his job.

The next ten years, Professor Thurow said, will be a transitional period for economic philosophy. We are growing out of an economy set up to serve *Homo economicus*—but we do not know where we are going because "these fundamental questions are still up for grabs."—*R.A.*

Women in Physics

"Women in physics are discriminated against, and this is ridiculous!"—this was the concluding statement of Dr. Vera Kistiakowsky, Senior Research Scientist in Physics at M.I.T. who chairs the American Institute of Physics' Committee on Women, at an M.I.T. symposium late in the winter.

According to the 1970 Register of Scientific and Technical Manpower, only 4 per cent of U.S. Ph.D.'s in physics belong to women. Such women are often oldest daughters or only children; "these are usually women who see themselves as individuals first and women second," said Dr. Kistiakowsky.

Why so few women in physics?

☐ Women are discouraged at the stage of graduate study; significant numbers drop out of graduate programs before completing the Ph.D. One problem is negative thesis advisers: "If an adviser expects a girl to drop out or to perform poorly, it can easily become a self-fulfilling prophecy." And the scarcity of women is self-perpetuating: "It is often difficult to go on if there are so few role-models."

☐ In almost all categories women are paid less than men employed as physicists; this is because men are often promoted into higher-paying management positions, women seldom. "The percentage of women in management is significantly lower than one would expect."

☐ Many institutional policies and rules never aimed at women have discriminatory effects. Anti-nepotism rules are an example. Maternity leaves are another problem.

A suggestion: "People must start thinking of women as physicists rather than thinking of women physicists as women."—*J.M.*

A Dearth of Miners

"Present shortage is worsening each year due to lack of graduates" . . . "Definite shortage" . . . "Acute shortage"...

These comments from mining companies were obtained in a survey of supply-and-demand imbalances conducted by the Engineering Manpower Commission; they refer to a dearth of mining engineering graduates. The Commission asked employers of engineering graduates and technicians, in all fields, to specify the curriculum areas in which they thought universities were turning out either too many graduates or too few. Admittedly the survey was done at an early stage in the current recession (early in 1970); almost all the replies express needs for more graduates, and very few draw attention to surpluses. But the editors of the survey remark that the same employers were "projecting a substantial cutback in their hiring plans," so that the many who called for a greater supply of graduates in certain areas "were not, in general, influenced by unrealistically optimistic visions of expanding employment."

From only 150 replies covering the whole range of fields, few firm conclusions can be drawn, but it is clear that employers were having difficulty hiring enough graduates in mining, and also in power and chemical engineering. Many reported the same experience in relation to civil engineers, but on the other hand some found there were too many in this discipline. A surplus of aerospace and electronic engineers (of "gadgeteers" was already abundantly evident.—*F.W.*

Recession Hazards

The financial trauma now gripping higher education could be the "essential stimulus to a great leap forward." But most institutions will instead succumb to the countless influences which now press against greater creativity. Indeed, Jacqueline A. Mattfeld, Dean of Academic Affairs and Associate Provost at Brown University, told New England members of the American Alumni Council this winter, there is now "a crisis in self-confidence, a sudden faltering of purpose" in American universities which she fears is "debilitating and ultimately destructive."

On what factors does Dean Mattfeld base her fears?

☐ More than half of university faculties are tenured. When budgets must go down, these teachers are immovable; it is their younger colleagues in newer fields of work who must leave. Today's depression "promises to freeze us into strange and intolerable shapes," said Dean Mattfeld.

☐ The sources of a university's prestige are in the past, not in the future. In times of uncertainty, do we have the courage to trim programs in which traditional excellence has been achieved, and so nurture new programs on which future excellence will depend?

☐ In today's conditions, how can universities improve their teaching? It is no accident that better teaching means more personal contact between students and teachers, an "enormous increase" in time and effort. Striving for economies, we are being forced into providing only facts instead of learning, Dr. Mattfeld said.

☐ The greatest service to be rendered by a university's leader is to guide it into the future. But hard-pressed to resolve the daily problems of keeping the doors open and the lights burning, how can administrators find the time and energy to assure "the further perfection of the university?" Dean Mattfeld asked.—*J.M.*

The One Culture

While you and i have lips and voices
which are for kissing and to sing with
who cares if some oneeyed son of a bitch
invents an instrument to measure spring
with

—e. e. cummings

The poet was wrong, and the division he speaks of cannot be borne, designer Charles Eames told the American Association for the Advancement of Science at its annual meeting in Philadelphia. Both artists and scientists produce a lot of fuzzy thinking about how different they are, he said, but what makes a good scientist is what makes a good artist: discipline.

That which we value, he explained, ought to have several qualities: it must be costly, it must be of a universal coin, it cannot decrease in value as more people obtain it, and it cannot satiate us once we have it.

What will fulfill these conditions, Mr. Eames said, is mastery of a craft. The universal coin is our own self-involvement, our commitment to our craft. And that coin is the same for all crafts, whether an art, a science, or anything else.

Unfortunately, there are forces that try to impose exclusiveness. Those on the edges of art, the curators and gallery salesmen, encourage us to think of the fine arts as formal and separate from our everyday lives. But the artist cannot separate his art from his daily life. The scientist, encouraged by divisions in the universities, tends to abandon, when he comes to art, the disciplines that make him a good scientist. He puts on an art-hat and grows sentimental or romantic to deal with the feelings a piece of art invokes.

A scientist who remains a scientist—and he can in this way become an even better one—will see that there is no division. In his commitment to his craft, he will find a common spirit and language with the artist. The artist, from his side, can reach this common ground by working harder to explain the world he sees rather than to explain himself to the world; for mere self-expression, Mr. Eames said, is as inconsequential in the arts as it is in the sciences.

Both men will learn that their task is the same, he said: to look at what seems to be utter chaos, and to discover the relationships and inferences that are not readily apparent. To understand, and to explain.—*J. K.*

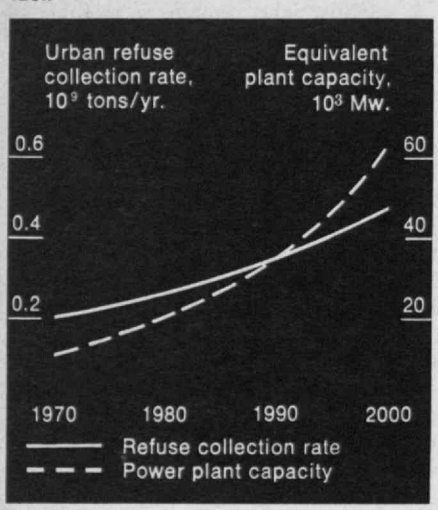
The Refuse-Fueled Power Station

We often say that coal and oil are non-renewable. We take them out of the ground and put nothing back in. Not quite true. American cities produce about 200 million tons of refuse per year. Used as a fuel in power-station boilers, it would supply about 8 per cent of the country's electric-power requirements. And the refuse supply is increasing not only in quantity but in calorific value (*see graph*).

European refuse is behind America's in heating power. Nevertheless, since 1960 Germany has built 20 steam-generating refuse-burners, which together dispose of the refuse of about 18 per cent of the country's population. The steam is used for a variety of purposes, including power generation. Power generation dictates certain minimum conditions of steam temperature and pressure, so such plants burn fossil fuel as well as refuse.

Can this European experience be applied in the U.S.? A joint study by Aerojet-General Corp., Foster Wheeler Corp., and Cottrell Environmental Systems Inc. seems to show that it can. The study's conclusions to date were presented in three papers at the winter meeting of the American Society of Mechanical Engineers in Washington. More recently it was announced that a 300-ton/day refuse burning demonstration is to be carried out at a Union Electric Co. power plant in St. Louis, Mo., and that a 1200 ton/day steam-generating garbage burner is to be built in Saugus, Mass., in a joint venture by Construction Engineering Inc. and the state's biggest disposal contractor.

Although refuse is being generated in the U.S. at an increasing rate, its energy content is rising even faster. In countries with less energetic trash than ours, urban waste is already widely used as fuel.



Urban refuse has to be disposed of somehow. Aerojet-General's R. M. Roberts and E. M. Wilson find that, regarded simply as a method of disposal, combustion and steam generation can be cheaper than sanitary landfill. But the capital cost of the plant is high—a refuse-burning power plant costs about as much as a conventional one, i.e. much more than an incinerator. Messrs. Roberts and Wilson examined ten alternative furnace schemes and then worked out in detail the economics of a power plant based upon the most cost-effective of them. A 400-Mw. power station fueled with refuse and coal, they calculate, would cost $63.4 million to build and would consume 2,800 tons of refuse per day. Annual cost, including amortized capital cost, would be $18.73 million, and the station would earn $18.76 million a year from its electrical output. Re-usable materials, such as glass and metals, could be extracted before combustion. (In the St. Louis demonstration, refuse will be mixed with coal in a 1:9 heat-value ratio. Ferrous metals will be removed before mixing, but all other components will be left in.)

Urban refuse has one advantage as fuel: it is low in sulfur (0.1 to 0.2 per cent by weight). Moreover, fired on agitating grates, it gives less fly-ash than pulverized coal for a given energy.

A. P. Konopka, of Cottrell Environmental Systems Inc., concludes a study of the air-pollution aspects of refuse-burning by remarking that by this technology "the national SO_2 problem could be somewhat alleviated"—but not enough. "Perhaps a more significant rationale for the use of refuse as a fuel is the cost-effectiveness of such use as a means of solving the national solid-waste disposal problem, while preserving the quality of our air resources."

The refuse-burning power plant seems a classic candidate for a descent between two institutional stools: as a power-plant, its virtues are not dramatic; as a means of solid-waste disposal, it suffers from high capital cost. The American research reported here was funded as air-pollution control, before the unification of the Environmental Protection Agency. However, the E.P.A. is contributing $1,743,600 to the St. Louis project.—*F.W.*

Let Us Have Less Light

Electrical energy supplies about 8 per cent of all the applied energy the United States uses in a year, yet producing that electricity takes about 25 per cent of the energy generated by all sources. Architects like himself, Richard Stein (of Richard Stein and Associates) told the American Association for the Advancement of Science last winter, must look carefully at how electrical energy might be conserved.

Lighting buildings accounts for 40 per cent of all the electrical energy sold, he said; too much of it wasted. Several studies, as recent as 1968, found that between three and ten foot-candles of illumination permitted one to read efficiently, and that higher levels might increase one's fatigue; yet New York City's Board of Education requires 60 fc. in classrooms (up from 20 fc. in 1952), and libraries have gone from 20 fc. in 1952 to 70 fc. Advertisements by light-fixture manufacturers have suggested 90 fc. in new office buildings.

The Illuminating Engineering Society, Mr. Stein continued, says that contrasts in light level are to be avoided, and a whole space must be lighted evenly—an unverified axiom, he thinks, for the eye moves easily between bright snow (1,500 fc.) and tree shadows (20 fc.). Such alternations are a medically recommended form of eye exercise.

If all buildings, old and new, were lit only as necessary, Mr. Stein said, we would save 4 per cent of our total expenses for electricity.

. . . and Heat

Another way of saving would be to avoid electric heating, which gives "less than half the efficiency with which the fuel can be used if it is converted to heat at its point of use." Six years ago, only 22 per cent of new homes were electrically heated; now the figure is 36 per cent. Lower rates are usually awarded to all-electric homes, Mr. Stein noted, which means that the other subscribers are paying a "massive" subsidy.

Thoughtful use of other electrical systems in buildings will also realize savings. For a hypothetical 50-story office building, Mr. Stein found, the use of daylight instead of artificial light wherever possible would mean that 10 per cent less heat would need to be removed by cooling equipment. During much of the year, windows that open would provide useful cooling at no cost—another 19 per cent. These two changes would result in a saving of 500,000 kWh. per year.

High-rise structures presently consume 36.8 million kWh. of electrical energy per million sq. ft. per year. It takes 424,000 million B.t.u.'s of energy to produce this much electricity. Mr. Stein calculates that these consumptions could be reduced to 13 million kWh. and 145,000 million B.t.u.'s.

The sum of all the energy used in erecting and maintaining buildings represents over half of all electrical

energy used in this country, he concluded. "We architects can either reinforce the rapid acceleration of energy use or dramatically reduce its rate of consumption. . . ."—*J.K.*

Must We Lionize the Overdeveloped?

Pleas to bring more technology to underdeveloped countries are routine; but what about the plight of the overdeveloped country?

By that, says Ezra Ehrenkrantz, President of Building Systems Development, Inc., architects and planners, of San Francisco, he means the country whose use of energy—for instance—is so lavish that still more energy is required to maintain a semblance of control over it.

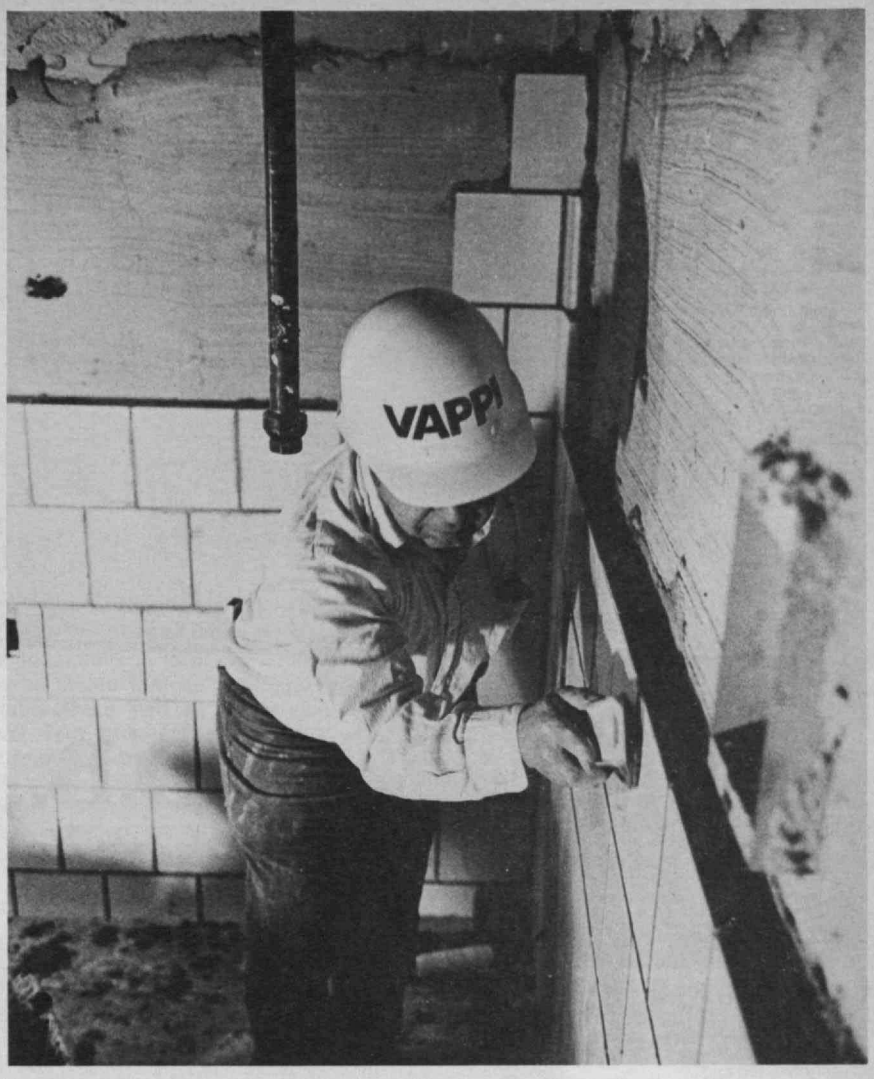
Mr. Ehrenkrantz used two examples to make his point at a Sierra Club conference on problems associated with electric power generation at Johnson State College, Vt., this winter:

☐ We have learned how to air-condition buildings, and now we "defy natural forces" by designing buildings with walls of glass facing the sun. To make such buildings habitable requires "feats of magic" by mechanical engineers—and lots of cooling energy, to move heat from the inside to the outside of the glass, whence it easily reenters to absorb yet more energy.

☐ We design air conditioning to yield comfortable temperatures at breathing level, rejecting the modest extra investment that would permit more comprehensive control. But where people's activities are mostly sedentary —school classrooms, for instance— many inhabitants, prone to poor circulation, have cold feet. So they turn up the heat, and two systems—both consuming energy—work against each other.

These examples are obvious and commonplace. Better solutions surround us in buildings from earlier traditions, said Mr. Ehrenkrantz—the massive use of insulation in colonial structures, solar shading and natural ventilation in tropical homes, evaporative cooling systems in desert locations.

It's unfortunate enough that we ourselves disregard these kinds of environmental common sense. But, said Mr. Ehrenkrantz, "it's catastrophic that our universities are teaching foreign students whose countries have acceptable environmental control techniques, which have evolved over time, to disregard them in favor of brute mechanical-force approaches."—*J.M.*



Meshkin 6 x 9.4 $490.
A rug from northern Persia, Caucasian in spirit. Many similar examples are available, in tones of light blue, cinnamon brown, gold, deep blue and ivory.

Kayseri Prayer Rug
3.10 x 5.6 $590.
The most finely woven Turkish rug, shown here in the classic 'mosque lamp' prayer design. Many examples are available in soft colors of rose, peach, medium blue and green.

Jozan $
8 x 10.2 $
An example of the type of Sarouk in egantly detailed design, wo tones o blue, re

F.O.B., Persia

Yalameh 7.2 x 11.6 $890.
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4.5 x 7.8 $3
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Calculate or Ruminate?

Puzzle Corner
Allan J. Gottlieb

Hi. As you probably know by now, our numbering system has left much to be desired. We'll try to change the system this time, by combining numbers with letters to indicate the month of publication. When you respond to a problem, use both letter *and* number.

I've had the pleasure of a few visitors lately. Harry Nelson came by to show me some of his "puzzle inventions" as well as some conventional puzzles. Last week one of my first M.I.T. roommates, Phil Rosencrantz, dropped by. We were 12 miles apart for the four years after graduation, but we both had to move 3,000 miles before we met.

The response to the chess-bridge alternation has been favorable, so the format will remain.

Remember to send problems and solutions to me at the Department of Mathematics, University of California, Santa Cruz, Calif., 95060; we publish one answer to each problem and acknowledge in print others as received—and we always welcome comments and suggestions.

Problems

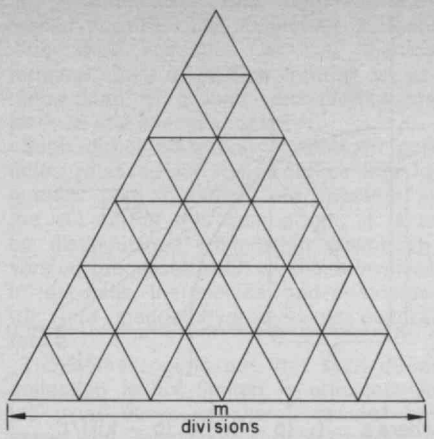
The following chess problem is from Harry Nelson:

M1 In the laws governing the game of chess, provision is made for the claim of a draw under a variety of circumstances. In particular, Law 12 states (in part), "The game is drawn . . . 3. Upon demand by one of the players when the same position appears three times, provided that the same player has the move after each of the three appearances of the same position on the chess board. The position is considered the same if men of the same kind and color occupy the same squares, and the possible moves of all the men are unchanged. . . ." I have found a position reachable by legal play which can occur 21 times without either player being able to demand a draw; can any of your *Technology Review* readers do better?

A sympathetic offering from Stephen Kent:

M2 N soldiers are lined up to be shot. The shooting proceeds as follows: The shooting begins at the left. The first man is skipped, the second man is shot, the third man is skipped, the fourth man is shot, etc., every other man being shot. If a man is not shot, he moves to the end of the line at the right. The last soldier remaining after the shooting is allowed to live. For N = 5, B is shot first, then D, A, and E, and C survives. In general for N soldiers, where should one stand in line if he wishes to live?

A banking puzzle sent in by Harry Zaremba:



M3 The main lobby floor of a new bank building was finished with a mosaic surfacing in which the central feature is a large, contrasting colored triangle patterned from small, equilateral triangles as shown in the illustration above. The floor contractor claimed that it required 10,000 individual units to form the large triangle, and he stated that he could retire comfortably if he had as many dollars as there were triangles of all sizes within the triangular pattern. How many mosaic units m were along each side of the large triangle, and how many triangles of all sizes, including the large one, are to be found within its bounds?

I overheard this one in the mathematics common room at the University of California in Berkeley:

M4 Prove that if 51 integers are chosen from the 100 integers 1, 2, 3, . . . 100, then among the 51 are two a and b such that a evenly divides b.

Winslow H. Hartford offers the following pair of apparently difficult number-theoretic problems:

M5 Find the rational numbers A, B, and C such that

(1) $A^2 - B^2 = 6$, $B^2 - C^2 = 6$, other than the trivial solution $A = 7/2$, $B = 5/2$, and $C = 1/2$.

(2) $A^2 - B^2 = 29$, $B^2 - C^2 = 29$.

Speed Department

Dr. H. B. Levine offers a riddle:

SD1-M "Igor, glorious comrade, now dot you've been elected to de Soviet Applied Problems Society (S.A.P.S.) I'm gung gif you a problem: De sum of de ages from mine sons Alexei, Baliabovitsch and Carlschvanz is precisely nine times Alexei's age. Naxt year de sum vill be six times vot Alexei's age vill be naxt year. And de following year it vill be five times vot Alexei's age vill den be. So, how old are they now?"

"Tovarisch, you're maybe some kind of a nut? It's unpossible to tell!"

"Igor, don't make by me no troubles! Is possible to tell ven you take a serious approach."

Another bank problem, this one from Jack Parsons:

SD2-M In a game between a player and a banker, the latter rolls two dice once. The player then rolls the two dice once. If the player rolls a higher point than the banker, he wins even money; otherwise he loses. What is the player's expectation in this game—that is, over a long series, how much can he expect to win or lose per game?

Solutions

Because of the confusion in numbering, let it be understood that these are solutions to problems which appeared in the January issue of the *Review*:

51 Can the following contract be made against any defense?

	♠ 7 3 2 ♥ 5 4 2 ♦ A 10 9 7 6 ♣ 3 2	
♠ K 6 4 ♥ K J 7 6 ♦ K J ♣ K Q J 5		♠ 8 ♥ 9 8 ♦ 8 5 4 2 ♣ 10 9 8 7 6 4
	♠ A Q J 10 9 5 ♥ A Q 10 3 ♦ Q 3 ♣ A	

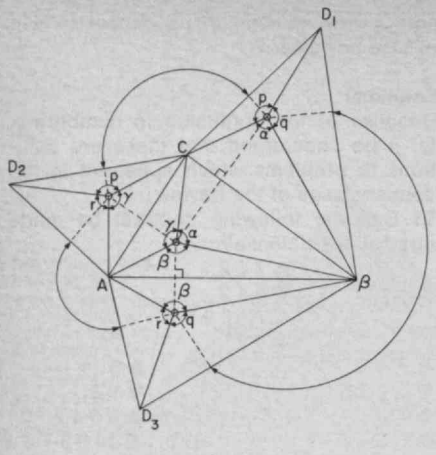
South	West	North	East
1 ♠	Double	2 ♦	Pass
3 ♠	Pass	4 ♠	5 ♣
5 ♠	Double	Pass	Pass
Pass			

This solution is from Charles F. Andrew: The key to this problem is to either gain an entry to dummy through the ♠7 after the diamond suit has been set up or, if West thwarts this, to endplay West. East's cards are immaterial. One diamond trick loss is unavoidable unless West misplays. One trick only can be lost in hearts, or alternatively one in spades if West lets South on the board with the ♠7. For West to keep South off the board requires giving up the ♠K. The play: The best opening lead is ♣5. A diamond lead costs West a trick; a heart or spade lead merely anticipates later plays. South wins the ♣A and leads the ♠Q to remove East's ♠8. West has to hold up the ♠K. South next turns to a diamond to clear the way for setting up North's diamonds; he leads ♦Q. West must cover. North takes the ♦A. North now must lead a low club and trump so that when West is next put into the lead he cannot put South in with a club lead. South now leads the ♦3 and puts West in. West is faced with leading a heart; otherwise he puts North in. It does not matter what he leads; South wins and now leads ♠9. If West ducks he will lose his ♠K to South's ♠A. He must duck, however, to keep South from the board. South then takes West's ♠K. South now leads out his trump and West has to throw his clubs. Finally both South and West have only three hearts each. West is now put on lead with the ♥3 for West's second trick. He is endplayed and must lose the last two hearts to South whatever he leads.

Also solved by 24 other readers—a list simply too long to print here.

52 A sphere is inscribed in a tetrahedron (not necessarily regular). From the four tangency points, lines are drawn to the three adjacent vertices. Prove that the three sets of angles thus formed are equal.

The only response is from Richard Jenney, whose four tangent points are indicated as the points surrounded by small circles in the drawing at the top of the next page.



$p + q = 360 - \alpha = \beta + \gamma$ (1)
$p + r = 360 - \gamma = \alpha + \beta$ (2)
$r + q = 360 - \beta = \alpha + \gamma$ (3)
$p - q = \beta - \gamma$ (2) − (3) = (4)
$p - r = \beta - \alpha$ (1) − (3) = (5)
$r - q = \alpha - \gamma$ (2) − (1) = (6)
$p = \beta$ (1) + (4) = (7)
$q = \gamma$ (3) − (6) = (8)
$r = \alpha$; (3) + (6) = (9)

α, β, and γ run clockwise in each face. Q.E.D.

53 Given a circle [of radius r and center (h,k)] and a point P [having coordinates (p,q)], find, without using calculus, the coordinates of the point B on the circle having the property that the line segment PB is tangent to the circle.

J. Richard Swenson submitted the following solution:

First, eliminate some unnecessary complexity. Let the coordinate system of the original problem be denoted by (X,Y). Then move the center of the circle to the origin by a simple translation,

$x = X - h$, $y = Y - k$.

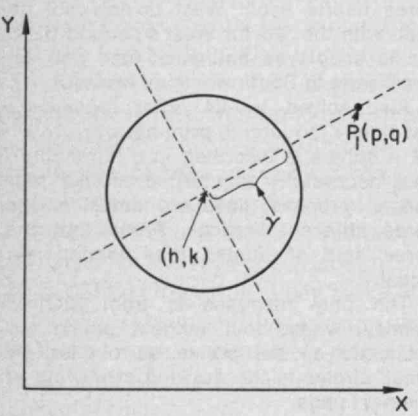
Now change the radius of the circle to 1 by changing the scale of the coordinate system

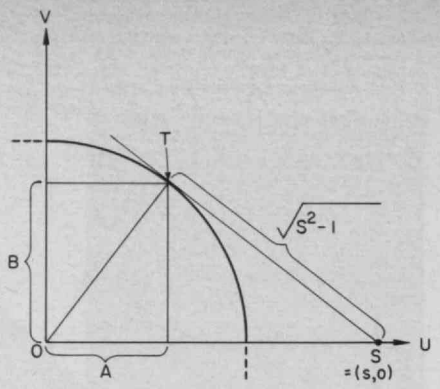
$U = x/r$, $V = y/r$.

Now rotate the coordinate system so that the point P lies on the horizontal axis with coordinate (s,O):

$u = U \cos\theta + V \sin\theta$
$v = V \cos\theta - U \sin\theta$
where $\theta = \arctan(q - k/p - h)$

Geometrically we have





where $s = (\sqrt{(p - h)^2 + (q - k)^2})/r$.

Now given the normalized situation above, it is clear that angle STO is a right angle. Since we know that OT = 1, OS = 1, and TS = $\sqrt{s^2 - 1}$, we can, using similar triangles, deduce that

$A = \cos\phi = 1/s$
$B = \sin\phi = \sqrt{(s^2 - 1)}/s$.

Unwinding the normalization, we find that T has (X,Y) coordinates of

$h + (r^2/[(p - h)^2 + (q - k)^2])[(q - k) - (\sqrt{(p - h)^2 + q - k)^2 - 1})(p - h)]$
$k + (\ldots)[(p - h) + (\sqrt{(p - h)^2 + (q - k)^2 - 1})(q - k)]$

As a footnote, Mr. Swenson writes that if P is inside the circle, then the above can be reinterpreted as:

Given P inside the circle, determine the tangent points of a single point (S, T, T') such that TPT' is a straight line.

And, he adds, the original problem "is so simple to solve geometrically that I cannot imagine anyone using calculus."

Also solved by Richard Jenney, Burton M. Posthill, R. Robinson Rowe, and Harry Zaremba.

54 All cows eat always at the same rate. Four cows eat three acres of grass in two weeks; three cows eat three acres of grass in three weeks. How long will it take five cows to eat six acres?

Many people got this wrong. A correct solution came from Claude M. Rabache:

A further assumption is that all grass grows always at the same rate g, starting from height H if left alone. Cows eat at rate e but grass reduces at rate (c/a)e where c/a is bovine density in cows per acre. An "eaten" acre is essentially grass that shrinks from H to nothing as cows eat grass faster than it grows (an assumption that will verify itself). Therefore,

$H = t[(c/a)e - g]$. But
$H = 2[(4e/3) - g]$ and $3(e - g)$,
from which
$e = 3g$.

If t_x is the time in question, then
$H = t_x[(5/6)3g - g] = 3(3g - g)$, and
$t_x = 4$ weeks. In general,
$t_x = 6a/(3c - a)$, or
$c/a = 2/t_x + 1/3$

If c/a is such that $(c - a) = 0$, then $t_x = \infty$ and the grass stays at its starting height (at least 1/3 cow per acre). If (c − a) is negative, then the grass will obviously continue to grow past its starting height.

Here are two novel attempts at this problem:

From the Rev. Chris F. Neely:

The problem's hard to calculate,
unless—like cows—you ruminate.
Our problem cows eat four days' food,
but on the fifth cuds must be chewed.
Four hungry beasts graze four days straight.
Days five and ten they ruminate.
And thus the 14 days have ended
with 48 "grazing days" expended.
Four cows (less one) move to new grass
but cannot eat a bite, alas.
Until day two, then graze for four,
then chew their cud and graze some more.
Three cows grazed 16 days this round
for 48 grazing days, I found.
Now, any five cows eating tandem
would surely chew their cuds at random.
(Eliminate the ruminant—while four cows graze,
the fifth one can't).
Six acres grazed, five "average" kine?
Twenty-four days should do just fine!

And one from Julian Pathe:

According to the new permissive math, one pregnant cow eats 1.5 acres in three weeks. At a later date, with all cows using the pill, the original four cows will have increased to five, eating six acres in 3.6 weeks. But the probability of the fifth animal being female is only about 0.5, and we don't know what the bull was doing the night you went to press.

Other attempts and/or solutions came from 22 readers, and we're sorry that space is simply too short to publish the list.

55 Let F_n be the nth Fibonacci number ($F_0 = 0$, $F_1 = 1$, $F_i = F_{i-1} + F_{i-2}$). Prove that $F_{n-2}{}^4 \equiv F_{n-1}{}^4 \equiv F_{n+1}{}^4 \equiv F_{n+2}{}^4 \equiv 1 \pmod{F_n}$.

Here is Alan LaVergne's answer:

First we observe that since
$F_{n+2} = F_{n+1} = F_{n-1} = -F_{n-2} \pmod{F_n}$
it is sufficient to prove that
$F_{n+1}{}^4 = 1 \pmod{F_n}$.
We will prove that (*)
$F_n{}^2 = F_{n+1}F_{n-1} + (-1)^{n+1}$
This will do the job, since then
$F_{n+1}{}^2 = (-1)^n \pmod{F_n}$
so that
$F_{n+1}{}^4 = (-1)^{2n} = 1 \pmod{F_n}$.
For proof of (*): First it is true for n = 2:
$1^2 = 2 \cdot 1 - 1$.
Now if it is true for n, then
$F_{n+1}{}^2 - F_{n+2}F_n = F_{n+1}{}^2 - F_{n+1}F_n - F_n{}^2 = F_{n+1}(F_{n+1} - F_n) - F_n{}^2 = -(F_n{}^2 - F_{n+1}F_{n-1}) = (-1)^{n+2}$.

Also solved by Robert Baird, Winslow H. Hartford, Richard Jenney, John N. Pierce, and R. Robinson Rowe.

Better Late Than Never

Several solutions to problems published in the October/November issue have come in:

41 Mr. and Mrs. Herve Thiriez and Douglas Goodman and **43**
42 Mr. and Mrs. Thiriez
44 Mr. Goodman and Mr. and Mrs. Thiriez
45 Mr. Goodman, H. W. Hardy, and (a beautiful solution) Peter L. Balise

Fred Heutink has supplied solutions to problems **53** and **54** from the December issue.

(*Book Reviews continued from p. 9*)
the presentation. Unfortunately, this reviewer cannot certify that references have always been selected in an entirely objective manner, and he feels that Dr. Morgan often weakens his arguments by trying to bolster statements of fact with bits of adverse interpretive opinion (e.g., regarding motivations). But even after making allowance for a certain amount of bias, much of the material remains so startling and disturbing that it should be carefully studied by anyone interested in plans for future developments in the United States.

In discussing the Corps' reluctance to admit error, Dr. Morgan quotes from the records to show that the Corps sometimes saves face by simply claiming credit for pioneer work on innovations it actually had vigorously opposed. Busy legislators are not in a good position to investigate and challenge claims made by the powerful Corps of Engineers, so the history-*re*writing tactic can apparently be used effectively to help the Corps maintain its prestige and dominance in the field of great public water projects.

Now that environmentalists are at last succeeding in blocking exploitation of a few of our best remaining wild areas, Dr. Morgan fears that the Corps will try to insure its future by extending its dominance into the very fields of conservation in which it has exhibited its greatest insensitivity and shortsightedness—and he is against such a move.

It will not be easy for the Corps to brush aside Dr. Morgan's criticisms, as Dr. Morgan speaks from an extensive background of pioneering experience in three different fields: the engineering of major river projects, education, and social relations. Among other things, he was President of Antioch College, and first Chairman of the Tennessee Valley Authority. Perhaps multiple frustrations have caused Dr. Morgan's book (and this review) to be unduly biased against the Corps, but the Corps seems to be so well equipped to protect itself, and so willing to overwhelm its opponents with ridicule, that it is believed that at least some of that bias is not entirely "undue."

Energy at High Efficiency

Book Review
Ralph W. Moir
Physicist, Lawrence Radiation Laboratory
University of California

Direct Conversion of Nuclear Radiation Energy
George H. Miley
American Nuclear Society, Hinsdale, Ill., 1971, 518 pp.

Direct conversion of nuclear radiation energy began in 1913 with the first Beta Battery—an evacuated metal chamber with an encapsulated radon source supported on an insulator. The penetrating beta particles leaving the source charged up the walls to a potential of 150 kv., and energetic electrons directed against this electric force lost energy as they moved towards the collecting surface; thus after collection at the "battery terminal" they could flow through an external load to ground and thereby do work as in a chemical battery.

Such direct collection of charged particles released by radioisotopes and by nuclear and thermonuclear reactors is the subject of this monograph; it is to be distinguished from other direct-conversion processes such as those involved in fuel cells, thermionics, and photoelectric and magnetohydrodynamic generators.

The author points out that such direct collection is not limited in efficiency in the usual sense of energy devices because the temperature of the working "fluid" is so high. Efficiency may theoretically be essentially 100 per cent. At a time when society is in need of "clean" and efficient energy sources, the possibility of escaping from the constraints of the usual heat engine—even though seemingly remote—excites the imagination and should stand as a challenge to scientists everywhere.

Most direct-collection devices built to date have been special-purpose, high-voltage (hundreds of kilovolts), low-current (nanoamperes), low-power (milliwatts) sources based on radioisotope emissions. They have found use in space, where long life and low maintenance are assets which overcome the disadvantages of low power; and they have also been used for timing circuits and instrumentation.

There remains a potential for much higher outputs—ranging even to those of interest in large central power stations—from devices using fission and thermonuclear emissions. Fission-electric cells have severe breakdown problems due to the high voltages required (4 Mv.) and the high level of background radiation inherent in fission. Thermonuclear-electric cells have the advantages of operating at lower voltages (500 kv.) and of the fact that the cell can be removed from the radiation region, and this is a field to be watched closely.

The author discusses in a fundamental way two important limiting processes: secondary-electron effects and voltage breakdown. Whether direct-collection devices are to remain laboratory curiosities or are to be developed into useful devices will depend on the interest and support in research and development in these fields.

Dr. Miley attributes in part to an early decision by the National Aeronautics and Space Administration the fact that the direct-collection cell has not now been well developed even for low-power applications. This was N.A.S.A.'s plan to scale down turbo-machinery instead of developing the nuclear battery to provide a power source of 500 watts for use in space. Now the author hopes for what he calls "a new mental attitude by the designer," which will lead to a new look at the problems plaguing direct-collection devices and perhaps to their practical development.

Archeological Looting

Book Review
James W. Mavor, Jr.
Woods Hole Oceanographic Institution

Diving for Sunken Treasure
Jacques-Yves Cousteau and Philippe Doile
Doubleday and Co., Inc., 1972, 302 pp., $8.95

The members of the *Calypso* diving team led by Jacques-Yves Cousteau have much in common with the crew of *Nuestra Señora de la Concepción,* the 17th-century Spanish galleon whose treasure they seek. Wandering the oceans seeking adventure and discovery with a well-equipped research ship and with an uncommon freedom, most of the men of *Calypso* are young, spend long periods away from home, and have not yet developed the personal and business ties which restrain most of us.

This latest book of their adventures is the story of the looting of a treasure ship. Cousteau's wife, Simone, is against the hunt for gold. Cousteau, by way of excuse, announces that they are conducting the first systemmatic excavation of a coral-bound ship. And he has serious doubts about whether or not there is a treasure and sheepishly passes responsibility to his companions for the decision to go after it. If there is treasure, he fears that it will destroy the team just as the gold of the new world ultimately ruined the conquistadors after 150 years of wealth and glory. Alexander Dumas, the famous and vastly experienced underwater explorer and archaeologist, who has been summoned to take part in this paradoxical expedition, looks on skeptically and expresses astonishment at the team's devotion to their work, a cause ignoble at best and probably a financial loss.

The Spanish galleon which they seek sank in 1641 on the Silver Bank, a large and treacherous coral reef in international waters of the Dominican Republic. It was a flagship of the fleet of Tierra Ferma carrying gold and silver of the Inca in the declining years of Spanish domination of the Caribbean. Much of the treasure of this ship was salvaged by William Phipps, later governor of Massachusetts, in 1687. But more than $1 million dollars' worth may remain.

A channel is blasted out of the coral for *Calypso* to reach the site, and the difficult excavation requires breaking up hundreds of tons of coral accretions in which the wreck is buried. The narrative is the story of galleons, pirates, and exploitation of the American Indians, standard fare well told and relevant. In conclusion, Cousteau pleads unconvincingly that they didn't really want all that treasure, anyway.

In spite of the frank title, the text and the participation of Dumas imply an archaeological excavation as well as a

treasure hunt, so it seems fair to judge the book accordingly. Unlike most works on archaeology, there is no plea for proper recording and preservation of the finds. Rather than informing the reader of good excavating practice, the story is an incitement to plunder. Dynamite and sledge hammers are not the means of archaeologists. There is a lack of follow-up on finds of cannon, bottles, pipes, and pottery, all of which can help date or identify a wreck. It is exasperating to follow the discovery and recovery of artifacts without knowing whether or not they were tagged, recorded, and preserved—or attempts were made at dating or identification. There is no mention of cleaning the surface of the finds and sealing the metal to prevent flaking.

This picture portrayed by the book is probably false, because Cousteau and Dumas know better. Cousteau and his team are pioneers in underwater activity, truly modern seafaring people in a generally lost tradition. They built and used the first archaeological airlift. They well know a systemmatic excavation, and perhaps this was one. But the tale as told leads us to believe otherwise.

Few wrecks have been excavated systematically. Those that have, principally in the Mediterranean, took several years of seasonal work, without the obstacle of coral. Cousteau and his team spent five years on the Grand Congloué wreck of a large 2nd-century B.C. ship near Marseille, a project that makes the subject of this book trivial by comparison.

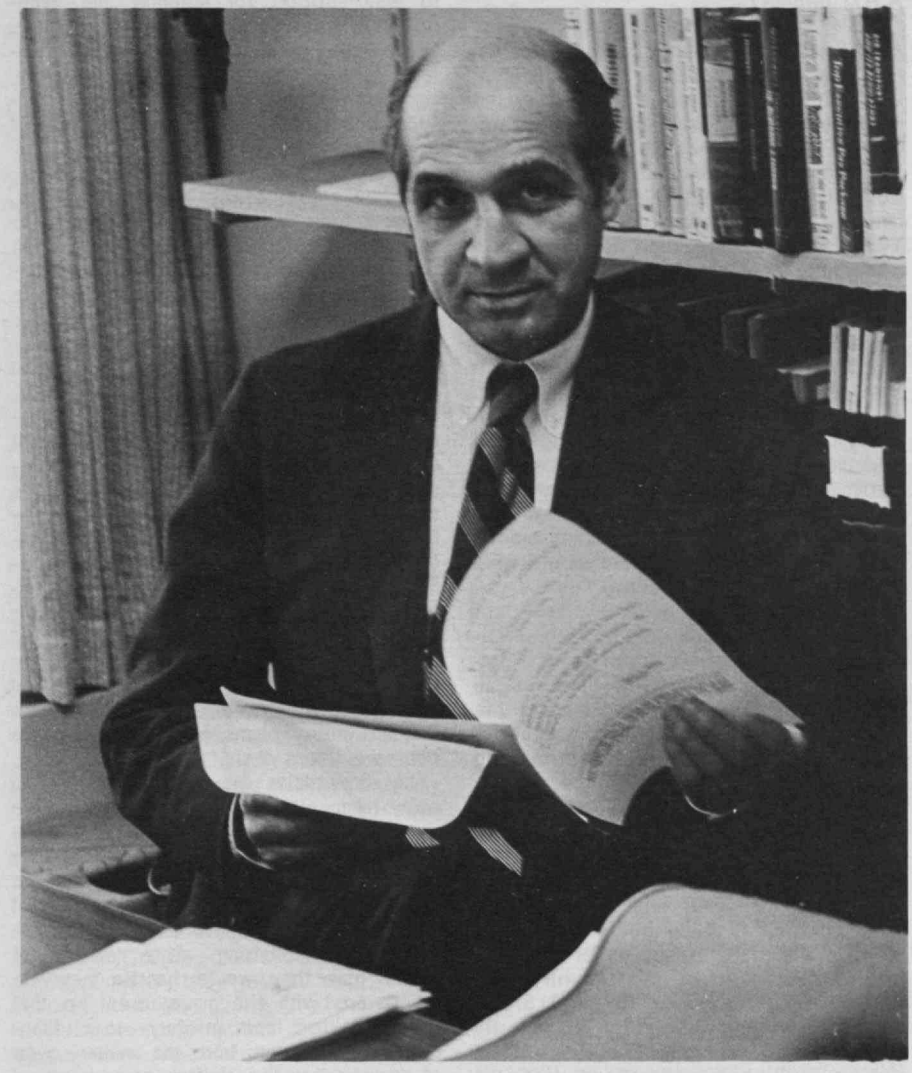
The future of underwater excavation is uncertain because technology proceeds willy-nilly. In deep water wrecks lie preserved and relatively inaccessible. But 3 million scuba divers in the United States alone, few with knowledge of proper excavation techniques, can raise havoc; and the new ship *Alcoa Seaprobe* promises to send its great remotely controlled claws thousands of feet beneath the sea surface to grab and retrieve sunken vessels—an apalling prospect because cost and haste will almost surely dictate destruction. Fortunately, sometimes the natural hazards which caused —coral, currents, shoals, storms, inaccessibility—the wrecks tend to protect them from looters. Such is the case of *Nuestra Señora de la Concepción.*

Cousteau and his companions have shown that a coral-encrusted treasure ship is a difficult target but they have failed to discourage or to educate the diver-looters who will surely follow in their footsteps.

An Interview with
Emilio Q. Daddario

Science: Understanding Its Costs and Benefits

Technology assessment competently performed can go far toward restoring Americans' confidence in science and engineering. Without it, debates on issues more emotional than real will continue to do great harm to the nation.



Emilio Q. Daddario came to be one of the country's leading statesmen of science during his service as a Member of the House of Representatives from the First District of Connecticut from 1958 to 1970. Now Senior Vice President of Gulf and Western Precision Engineering Co., Mr. Daddario served as Lecturer in the M.I.T. Department of Political Science, teaching a seminar in "Congress and Policy for Science and Technology," during the first half of this academic year; just before his departure from the campus, Peter Peckarsky '68, interviewed Mr. Daddario for The Tech; *here are excerpts:*

Mr. Peckarsky: Mr. Daddario, what are your views of the organization for the study of science and public policy at M.I.T., now that you have been here for a few months?

Mr. Daddario: I see here at M.I.T. tremendous possibilities for taking interdisciplinary considerations into account. That is one of the most important aspects of public policy. How do you use science and how do you develop a workable relationship between the disciplines in the universities? These are so strictly placed into compartments for traditional and budgetary reasons that they are more inflexible than they ought to be.

Mr. Peckarsky: Could you comment on the proposition that the Congress needs an analysis group to perform scientific and technical analysis independent of any other governmental agency, in order to have some type of capability for evaluating an agency's program without relying on people who are dependent upon that agency?

Mr. Daddario: I was an original supporter of that program. It had a very interesting genesis, because the idea of developing an early-warning system really came from within the committee structure and its relationship to its advisory groups. Your President, Dr. Jerome B. Wiesner, served on one of those advisory groups. He said one day, "What we need is an early-warning system." From that developed the idea of technology assessment.

Over the course of years, it has become quite apparent that the Congress needs to assess its programs and especially the technology which is going to be used within the programs so that it will know where it's going, can better analyze what these programs will do, can show the public what courses of action there might be other than the one that is being proposed, and can help give a better understanding to the public so that some of the great emotion that is attendant on debates on many of the programs can be in some part lowered.

The S.S.T. is a very good example of a program which could have been analyzed. Alternative courses of action could have been discussed and the determination could have been made with real questions in mind rather than some that were more emotional than real. In the process of determining the S.S.T.'s fate, great harm was done to the nation.

There are a multitude of examples. The fact that we need so much energy these days, but that we cannot build energy plants because people do not quite understand what is involved. If these programs had been better understood, if we knew where we were going and why, what the cost relationships were, what the risks and negative side effects might be and how those problems could be cured over a period of time within these programs, the public might be in a better frame of mind than it is at the moment.

Mr. Peckarsky: Do you envision the establishment of something like the Congressional Research Service of the Library of Congress?

Mr. Daddario: No. The proposal is to establish a Technology Assessment Board within the Congress. Your question is a very interesting one, as it is proposed that the head of the Congressional Research Service be a member of the Board; it's also proposed that the Comptroller General be a member of the Board, that there be two members of the House, two members of the Senate, and either four or five public members. The Board would then put together a staff, under an executive director, which would then farm out research, but the Board would not develop an in-house capability. They would search for places where expert knowledge could be obtained on programs in which the Congress was interested. It would make independent studies and it would also take requests from the committees as to what those committees felt was necessary in order to analyze legislative programs presently being formulated.

Mr. Peckarsky: What budget is projected for such a group?

Mr. Daddario: The original proposal is something on the order of $5 million. That is without any question very low—but enough to get it off the ground. Somewhere down the line, to do the work that is necessary, it would most likely require a budget of close to $50 million per year.

Mr. Peckarsky: That would probably be enough money to have a fair number of analyses performed.

Mr. Daddario: Yes. If you had a budget of $50 million a year, properly done, and built up to that point as you developed the internal staff, you'd soon have a highly competent capability in the Congress that does not presently exist. They then would have to do an outstanding job in getting their work done in the private sector. If a staff were doing this year after year, spending that kind of money, it would develop a tremendous competence, and they would accordingly develop confidence in the people's minds about what was going on—simply because the work would be given great public visibility through reports, committee hearings, and Congressional debate.

Mr. Peckarsky: Do you see that coming into being in the near future?

Mr. Daddario: Yes, I do, because the government has been properly prepared. There have been studies, there have been hearings in the committees, and a feeling has developed about it not only in this country but abroad. The Organization for Economic Cooperation and Development, for example, has just recently held a meeting of the science and technology ministers of all of the O.E.C.D. countries aimed at the development of a policy on science and technology and in its report stressed the need for technology assessment as an important key to science and technology.

The National Association of Manufacturers has just passed a technology assessment resolution with the idea in mind that the public interest has to be served.

There are technology assessment studies in various of the executive departments. Beyond that, the legislation in the Congress has reached the point where it has bi-partisan support in both the House and the Senate. The feeling I get is that the Congress recognizes that it must do a better job in this area and that a capability such as this will help the Congress to do just that.

Mr. Peckarsky: What was your view of the level of scientific analysis during the A.B.M. debate?

Mr. Daddario: I think more important than the quality of the debate is that it occurred—the idea that people did get interested in what was happening. One of the great problems has been that the academic community has not become itself involved in public matters; there has been a certain remoteness. There will be more and more involvement, and there should be. The S.S.T. is an example.

The debate, however, ought to be confined to the facts rather than to the development of an appeal based on emotion. What we need is a way to develop a rational approach to government generally and to members of Congress specifically. A technology assessment capability within the executive and legislative branches of government could help us here. It would allow for discussions earlier in the ball game and would help to improve the level of debate.

Mr. Peckarsky: John Foster, former Director of Defense Research and Engineering, and a number of others have said that the U.S. is falling behind the Soviet Union in terms of the amount of money being spent on research and development, and that several years from now this might lead to the U.S. falling behind the Soviet Union. Have you gone into this topic?

Mr. Daddario: Over the past several years, there has been quite an obvious trend of diminishing support for research and development in this country and corresponding increases in the U.S.S.R. That's very important from a security point of view, and it affects our competitive position in international trade as well. If one considers the efforts that have been made by the advanced industrial countries—the United Kingdom, France, the Netherlands, Finland, West Germany, Japan—you will find that they have spent a larger percentage of their federal budget on basic research than we have. The situation, in both economics and national security, is developing into a more comprehensive one than has existed since the Second World War.

Mr. Peckarsky: To what factors would you attribute this downturn in money going into research and development?

Mr. Daddario: It's awfully difficult to specify the reasons, but whenever you run into an economic downturn such as we have in this country now, programs which have tremendous public interest value—the humanitarian programs—take precedence over all other programs, and, even though they are short-range programs, they are very important. I think the big problem is our ability to support those objectives and long-range research and development goals as well.

Somewhere along the line there has developed in this country an antipathy to science and technology. Perhaps that comes about because when we looked to science and technology to overcome problems in the social, political and economic areas of our society the answers weren't forthcoming. All of this has led to less support for science and technology. That is, of course, unfortunate. We're not going to solve these problems unless we have more knowledge, and yet we have not developed an attitude within the nation that recognizes this to be the case.

Mr. Peckarsky: M.I.T. has been trying, as you have no doubt been aware, to shift from financial dependence upon the Department of Defense to relationships with agencies more concerned with urban and domestic problems.

Mr. Daddario: This is one of the great problems in our society. It's been unfortunate, I believe, that we haven't recognized this long ago. We tried to point out in the Subcommittee on Science, Research and Development for many years that there was a trend developing away from military-oriented research. We indicated the need to develop, in the National Science Foundation, greater influence and more budgetary support over a period of time so that we could get away from the problems inherent in the military-supported programs. It was not that we were being prophetic; there were just so many signs available over the course of these years.

The universities are necessarily moving away from military programs because the monies are not available. It's as simple as that. The shame of it is that the adjustments did not take place in a more orderly way, both by the government having better programs and by the universities establishing as a matter of policy how they would handle their relationships with the government so that this transition from military- to civilian-oriented programs, from the military type of agencies to the civilian ones such as the Department of Transportation, would have been much easier and without the jar that has occurred.

Institute Review

M.I.T. as a "Happening"

What do alumni ask him about M.I.T. when President Jerome B. Wiesner travels around the country to meet them?

Four questions, he told members of the faculty at the annual dinner sponsored by faculty wives late this winter:

☐ What about student dissent? (The answer is simple, he said; the question merely demonstrates that alumni are always two years behind the times in their knowledge of M.I.T.)

☐ How about the financial problems? (That answer is easy, too—not because the problems are simple, but because the experience is so widespread; think of your own family budget problems, add four digits, and then think of all the exciting new things there are to buy.)

☐ What is the meaning of all the changes in educational programs? (Alumni ask that in recollection of their own experiences, when laboratories were long, quizzes were hard, and final examinations separated the men from the boys.)

☐ Is an M.I.T. education truly relevant to modern needs? (Everyone seems to worry about "relevance" these days.)

The answers to the last two questions are harder, said Dr. Wiesner—but they go to the heart of today's changes at M.I.T.

Young people are changing, because schools are better and because communications and other technology has brought them world experiences at an early age. No longer, said Dr. Wiesner, are M.I.T. freshmen content "to sit back and be told that some day they will understand why they must learn these things." And they bring to the Institute a "deep cynicism about the world" because they see, and sometimes experience, so many more of its problems.

Hence the changes in M.I.T.'s educational programs—to give students greater freedom to meet their own interests and to interact with the faculty on a new level of maturity.

The young people's awareness of problems is only one reason for trying to increase the relevance of an M.I.T. education. The other, larger reason, said Dr. Wiesner, is our growing understanding of the social effects of technological progress—a view of which we largely lost sight in our two-decade "preoccupation with high technology" after World War II, he said.

The Institute's response to these issues is a new effort to achieve true interdisciplinary collaboration. We see that problems to which technology now relates are very broad; we have achieved some success with interdisciplinary research; but now we must find a way to interdisciplinary living—and true interdisciplinary understanding.

Despite some unexpected frustrations on the way to these goals, M.I.T. is "a happening," said Dr. Wiesner—"there is so much here that no one of us can take it all in." Such is the intensity, he said, of everyone's effort to take part in the Institute's life and progress.

Admissions: Still in the Downswing

"We are probably still in a downswing," Professor Roland B. Greeley, Director of Admissions, reported at the end of this year's admission season. Applications for next year's freshman class stand at last year's level—down by 20 per cent from recent preceding years.

Professor Greeley puts the blame (at least in part) on four trends over which M.I.T. has little if any control:

☐ "Nationally, there is a swing of interest away from engineering and hard science and toward the social sciences and humanism in the eyes and hearts of the high school kids." The reasons are hard to identify, but he mentioned as candidates the technical employment situation and prejudice attached to concepts of the military-industrial complex. (Donald G. Dickason, Director of Admissions at Cornell University's College of Engineering, took a broader view in an address last fall before the Engineers' Council for Professional Development: "As a sociological group [applicants to colleges] have changed dramatically. From the well defined vocational motivation of the Puritan Ethic, the whole culture has moved toward peer-oriented guidance," he said. "Young people are less interested in personal achievement and more interested in the values which are set by their peer group.") The change is manifest within M.I.T., too, Professor Greeley continued, in the form of "a large upswing in interest in both medicine and law." Students want to be "socially useful instead of mechanistically, materialistically useful."

☐ The cost of an M.I.T. education is going up at the same time that the national economy is in a state of decline. Since fewer families are willing or able to pay, "our potential market is relatively, and perhaps absolutely, smaller."

Students are more and more often asking themselves, Why go to a good college? Is it worth the extra cost? Why go to a hard college? Is it worth the extra effort? "The prestige college no longer holds the same aura of desirability in high schools that it did before," Professor Greeley explained. He suggests the possibility of some sort of "cult of mediocrity.

☐ Coupled with the other trends is "a very significant increase in the quality of education in public institutions, particularly state universities." The path into a state university may involve less resistance than that into M.I.T., principally because of finances. Even if the same out-of-pocket expenses are involved in both cases, the graduate leaving M.I.T. will carry a sizeable debt which his state university counterpart does not.

Professor Greeley also mentioned four other situations over which M.I.T. can exercise a degree of control:

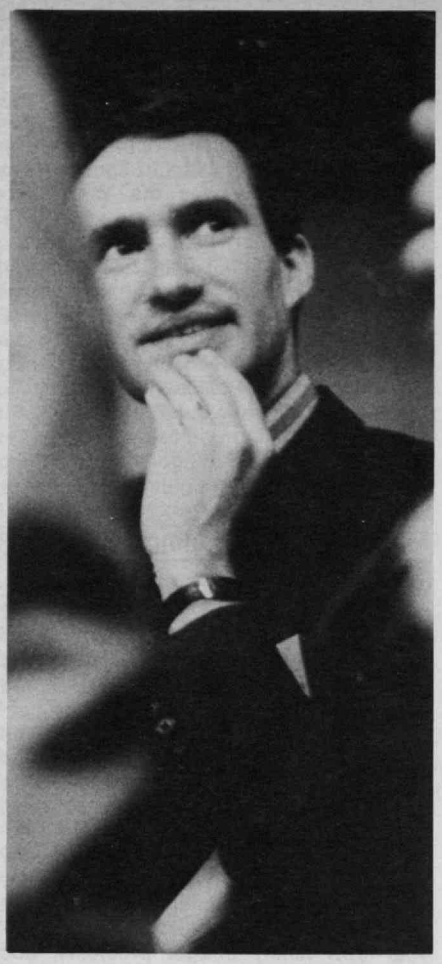
☐ "We have been re-orienting our interests toward social applications of technology—and this is going to be our greatest help in the next few years." M.I.T. can tell its prospective students that its kind of technology is applied toward socially-useful purposes, not toward feeding the military-industrial complex.

☐ "We're still fighting the graduate-versus-undergraduate syndrome." Professor Greeley tells his applicants that M.I.T. sees its mission as a "three-legged stool, of which the legs are undergraduate education, graduate education, and research—and that the first is as important as the other two."

☐ The feeling that M.I.T. is "hyperselective" is an issue which "has been bugging us over the years." Prospective applicants are sometimes scared off by M.I.T.'s reputation for being hard to get into—and hard to stay in.

How To Join the 20-Hours-a-Day Executives—and Why

The pioneers usually end up with arrows in their backs, said William J. McCrea,



William J. McCrea, '61, (right) shared the chair for more than 75 alumni at a seminar on "How to Start and Operate a Small Business and Make It Grow" on the campus early this spring; his co-chairman was Jamie C. Chapman, Ph.D.'66, shown in the bottom center with William W. Garth, Jr., '36 (left), keynoter, and Fred G. Lehmann, '51 (right), Secretary of the Alumni Association. The panel (top) on managing a new enterprise included Roger E. Travis, '59, William L. Abramowitz, '35, William B. Anderson, John C. Gill, Jr., '56, and David P. Parker, '63; and in the audience was (bottom left) Donald M. Dible, '62, whose own book on management, Up Your Own Organization, *was on prominent display.*

'61, President of Tech Films Corp. He and his company—in bankruptcy this spring—are a case in point, he told some 100 young alumni and guests attending a two-day seminar on How to Start and Operate a Small Business and Make It Grow in Cambridge in mid-March. But given the same scenario to repeat, said Mr. McCrea, he would do it all over again.

"We really had a ball for two years," he said. "But then it turned into a hassle," and the problem now is to get out of trouble gracefully enough so that you can start in again.

A living example, perhaps, of the hazards of the "three stages of growth" theory outlined at the same seminar by David E. Berlew.

Why go through it all, anyway? (Before you start, be warned that you'll spend 20 hours a day on the job and sacrifice most of your family and social life for an indefinite period.)

William W. Garth, Jr., '36, President of Compugraphic Corp., answered the question as keynote speaker, after summarizing his own career through two companies in the graphic arts industries—one built to $9 million and lost, the other started with $50,000 and now (still growing) over $20 million a year.

The possibility of substantial monetary reward is one reason, of course. Another, said Mr. Garth, is the company you keep, the "tremendous satisfaction from being a peer among the people who run businesses in New England.

"And if you start one of these things," said Mr. Garth, "you're particularly fortunate if you pick something so that when it's all over they say you've done something for mankind."

A Woman's Place

"What year are you at Wellesley?"

That question is one of the most irritating experiences of being an M.I.T. coed, Professor Emily L. Wick told the M.I.T. Club of Boston late last winter. It shows that many people—both within and without the Institute—are more aware of the exchange program with Wellesley than they are of the population of women students at M.I.T.

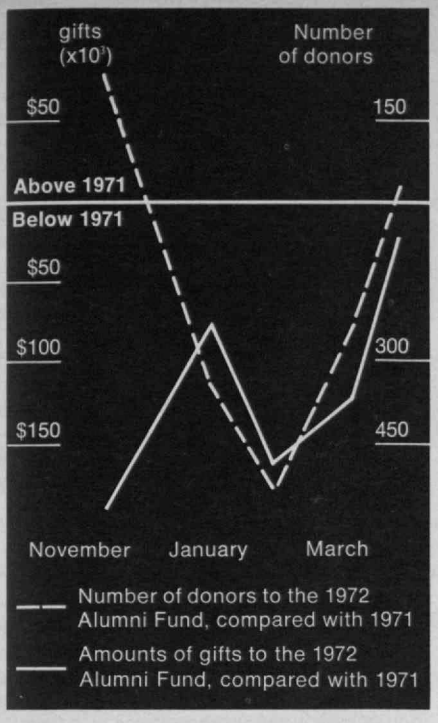
But the question does not come so often. Ever since 1969, when M.I.T.'s coed enrollment ceased to be limited by the housing available, the number of women students has been steadily rising. And as a result, says Professor Wick (who was until this winter Associate Dean for Student Affairs in charge of women students), with the increasing numbers, "the spirit and outlook of women students has changed. . . . No longer do you have to be better than a man to get in."

A few years ago, she said, "my job was helping to develop an *esprit de corps* among the women in McCormick Hall—establishing a tradition." Her efforts have now developed a momentum of their own; a "Women's Forum" which Professor Wick and Professor Mildred S. Dresselhaus organized for the January Independent Activities Period proved a much greater success than either had expected. It has continued to meet well into the second semester to discuss the special problems of women at M.I.T.—be they students, faculty, staff, secretaries, or faculty wives. Two of the topics of discussion have been job opportunities and legal rights.

But a woman's path to M.I.T. is still not an easy one. When a boy in high school is good at mathematics and physics, his guidance counselor will almost automatically recommend that he consider M.I.T. and CalTech. Not so a girl, said Professor Wick; the same counselor will often discourage a girl with the same qualifications. "And then there's always an Aunt Minnie to raise an eyebrow."

One result is not entirely bad: the women who come to M.I.T. have all thought very carefully about what they want to do—and that puts them "a jump ahead" of their male classmates.

Once here, both undergraduate and



Kenneth S. Brock, '48, Director of the Alumni Fund, finds 1972 an "intriguing" year. The figures above, comparing the 1972 Fund with the 1971 data base, show how a dreary late-winter prognosis for the 1972 Fund had given away to hope and optimism by early spring.

graduate women gravitate more than the men toward the Schools of Humanities and Social Science and of Architecture and Planning and the Departments of Chemistry, Biology, and Nutrition and Food Science. The Schools of Engineering and Management are less popular among women students.

And after a woman graduates, her chances for finding satisfying employment are not so bad: "Women who are good and who want to work will find that they can do so," Professor Wick said, and their opportunities are improving all the time. A recent survey, in fact, showed that for engineers entering the job market for the first time, salary offers to women now average slightly higher than those to men.

Alumni Fund: Down, Then Up Toward a Record?

It's an "intriguing year" to be Director of the M.I.T. Alumni Fund, said Kenneth S. Brock, '48—the man who has the job—at the Alumni Advisory Council's March meeting. "From gloom to glimmer" is the way he characterized the year—a "perplexing one," he said; the prognosis is improving, and records may be in reach after all.

By early in April the Fund had reached $1,753,129 from 13,861 donors—figures which are $21,462 behind and five donors ahead of the comparable point in the 1971 Alumni Fund campaign. The figures are so close, said Mr. Brock, that "the best way to characterize the fund this year is 'even with last year.' "

Why from gloom to glimmer? On January 9, the 1972 Fund had received only $778,839—down over $500,000 from the previous year's Fund at the same point. As recently as February 14 the 1972 Fund had only 11,778 contributors, 465 less than the previous year. Ninety days had essentially removed the deficit in funds contributed, and in only six weeks the comparative number of contributors had gone from minus to plus.

Will the 1972 Fund reach a new high in number of donors, for the eighth consecutive year? Can receipts top last year's $2,564,000, or even the 1969 record of $2,680,000? No answers until June, said Mr. Brock, but "the trends are in the right direction."

Undergraduate President: A Successful "Gut Level" Campaign

After a three-way fight which everyone at the Institute agreed was dull, even apathetic, Curtis Reeves, '73, a management major from Atlanta, Ga., is settling in as President of the M.I.T. Undergraduate Association. Only 1,100 votes were distributed among three president-vice-president slates—compared with 1,400 in 1971 and 1,800 in 1970.

Campaigning, Mr. Reeves and his running mate, Steven R. Taylor, '73, said they believe "today's issues are educational ones. . . . To us, the important things are those which affect the student daily; in the list of priorities that one draws in light of budget cuts, undergraduate education should still be at the top."

Lee Giguere, '73, Editor-in-Chief of *The Tech,* wrote during the campaign that Curtis and Reeves—"though they strongly single out education as an important aspect of student life—generally avoid taking a stand on particular issues." But they make an "important distinction," wrote Mr. Giguere, when they emphasize communication between the Undergraduate Association President and his fellow-students over communication between the U.A.P. and the administration. Mr. Reeves' and Mr. Taylor's campaign operated "at a certain gut level," said Mr. Giguere; "they don't give the impression of having calculated their stand so as to attract votes."

Ford Professorships

Ford Foundation funds to advance the study of international affairs at M.I.T. have made possible the appointment of four members of the School of Humanities and Social Science faculty to Ford Professorships: Evsey D. Domar and Charles P. Kindleberger in the Department of Economics and William E. Griffith and Lucian W. Pye in the Department of Political Science.

Dr. Domar is recognized for his research in economic theory, theory of growth, Soviet economics, fiscal policy, and economic development. Dr. Griffith, who directs the Project on Communism, Revisionism, and Revolution at the Center for International Studies, is widely known as an authority on the history, culture, and politics of Central and Eastern

In the past, said Curtis Reeves, '73, campaigning for Undergraduate Association President this spring, the U.A.P. "has often measured success by the number of deans' and vice presidents' offices he visited per week." His goals, said Mr. Reeves, would instead be closer communication with students and "change in educational policy" at M.I.T. (Photo: Alfred I. Anderson, 3rd,'72)

European countries. Dr. Kindleberger specializes in international economics and in monetary relations and has written several books in these fields. Dr. Pye's field of interest is comparative political behavior—particularly in Asian and other developing countries *(see above).*

Little Environmental Professor

The first appointment under a grant creating the Arthur D. Little Professorship of Environmental Sciences and Engineering has gone to Michael W. Golay, Assistant Professor of Nuclear Engineering; Dr. Golay will hold the Arthur D. Little Professorship for two years.

The new chair, funded by the Arthur D. Little Foundation, is intended to encourage and support younger M.I.T. faculty members interested in interdisciplinary environmental studies. Dr. Golay will work in the field of power generation and its environmental impact, participating in a program studying alternative strategies for meeting future electric power demand. Dr. Golay came to the Institute in 1971, following undergraduate work in mechanical engineering at the University of Florida and graduate studies in nuclear engineering at Cornell University. His teaching at M.I.T. has been in the field of power plant engineering.

A new Advisory Council representing state government, community, and industry interest has been named to help increase the M.I.T. Sea Grant Program's effectiveness in Massachusetts and New England. Members (above, with Francis W. Sargent, '39, Governor of Massachusetts, who spoke at their initial meeting) include James G. Kelso, Executive Vice President of the Greater Boston Chamber of Commerce, who is Acting Chairman of the Council; Lloyd Bergeson, '38, General Manager of the Quincy Shipbuilding Division of General Dynamics Corp.; Arthur W. Brownell, Massachusetts Commissioner of Natural Resources; Senator William M. Bulger of Fall River, Mass.; Thomas A. Fulham, Vice President of the Boston Fish Market Corp.; R. Frank Gregg, Chairman of the New England River Basins Commission; Edward J. King, Executive Director of the Massachusetts Port Authority; Jack A. Kyger, Ph.D.'40, Director of the Massachusetts Science and Technology Foundation; Bernard J. O'Keefe, President of E.G.&G., Inc.; Arthur F. F. Snyder, Senior Vice President of the New England Merchants National Bank; and Emily V. Wade, Chairman of the Board of the Boston Zoological Society.

Community Leadership

"I will be in a unique position when I get back . . . to share some information and insight on the problems of urban growth," Ben Brown recently told a visitor to his cubicle office.

Mr. Brown is young black political activist, a lawyer, and a member of the Georgia legislature. His main concern, which he likes to discuss with animation, is metropolitan government—specifically, what does it mean for black people and what do black people think of it?

His "unique position" will be a result of having studied for a year at M.I.T. as a Whitney Young Community Fellow (*see* Technology Review *for October/November, 1971, p. 97*). He is one of the first group of 11 participants in the program which began last September.

The Whitney Young Community Fellows Program is designed "to give selected leaders of minority communities throughout the U.S. the opportunity to spend one full academic year at M.I.T. preparing themselves to deal with the technical, social, and economic problems that confront their own communities."

The program is small and the fellows are chosen by application. Each pursues a research project which he proposed in his application; he works with faculty members and students (though the fellows come to learn they also have a great deal to teach) and attends classes. There is also a weekly seminar entitled "Issues and Strategies in Community Development," at which invited guests address the fellows.

Mr. Brown's project involves the structure, finance, and racial implications of urban growth. He is concerned with alternate policies for growth and the attitudes of black leaders—including case studies of six U.S. cities.

In addition, he has enrolled each semester in three courses which apply to his field. He works with two undergraduates who help him with his research under the Undergraduate Research Opportunities Program and with Professor Lawrence E. Susskind of the Department of Urban Studies and Planning, Professor Lloyd Rodwin, Head of the Department of Urban Studies and Planning, Melvin H. King of the Department of Urban Studies and Planning, and Professor Michael Lipsky of the Department of Political Science.

Mr. Brown is enthusiastic about the program: "It's helping to broaden my knowledge of the problems . . . so that I can hopefully be a better legislator."

And his enthusiasm is not unusual.

The other ten fellows (who come from Boston, San Antonio, Newark, and Minneapolis) are working in such fields as housing rehabilitation in an economically mixed community, minority entrepreneurship, the potential for a cable-television-based information service in a minority community, alternative educational models, a community arbitration mechanism, and decentralized government.

Real Estate Report

575 Memorial Drive, the Jordan Marsh warehouse on 150,000 sq. ft. of land immediately west of the M.I.T. campus, has been sold to Graham Gund, a Cambridge architect, for a reported price of $1.9 million. Many on the campus, aware that the Institute frequently buys nearby real estate when it can, were surprised; but Frederic W. Watriss, '41, Associate Treasurer, told *Technology Review* he doesn't think they should have been.

In this case, Mr. Watriss said, M.I.T. had neither the need nor the funds to add the property to academic plant; and the Institute did not consider it an economically feasible investment at the price. Indeed, he said, "there are many pieces of land that M.I.T. doesn't buy."

"A Phase of Facelifting"

When M.I.T.'s architects began designing the apartments to be built on Hamilton Street in Cambridge as part of the Institute's program to improve the city's housing stock, Mrs. Henrietta Jackson's house was in the wrong place.

With the new apartments finished, she would face a concrete wall. She naturally objected: she had spent time and money renovating her home; she liked the neighborhood; she didn't want to move.

What about moving her house? A far-fetched idea, but it turned out to be practical. Now Mrs. Jackson, who used to live at 121 Hamilton Street, is at number 145; when the apartments are finished, she will look out onto a small park with trees and flowers.

"Now that the dust has settled and we are firmly set on our new site," writes Mrs. Henrietta Jackson of Hamilton Street, Cambridge, to Walter L. Milne, Assistant to the Chairman of the Corporation, "I am more than satisfied." Indeed, she wrote, "the entire street is going through a phase of facelifting which I feel is a direct result of the involvement with M.I.T."

The Tech *speculated that the event marked the Ides of March, but anything having to do with spring will suffice. Following "a clarion trumpet call" from the balcony, some 20 toga-clad males "of indeterminate origin" entered the Student Center's Lobdell dining room one March noon-hour. Each picked up and carried out one "weakly protesting (prearranged) woman." End of event. After a few moments of silence, applause from the noon-time crowd. (Photo: Sheldon Lowenthal, '74)*

U.R.O.P. Expands

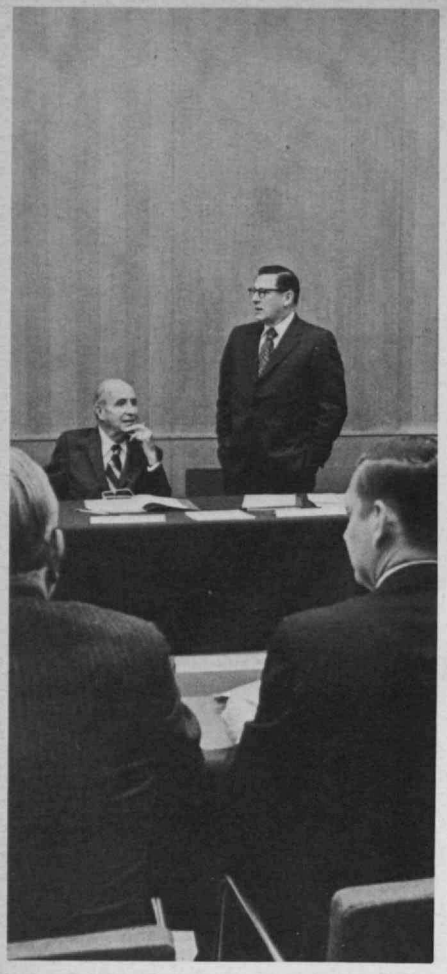
Twelve hundred students are now working in M.I.T. laboratories for academic credit or pay under the very successful Undergraduate Research Opportunities Program. But for some students, explains the Education Research Center's David E. Burmaster, '69, the range of opportunities on the campus is not enough.

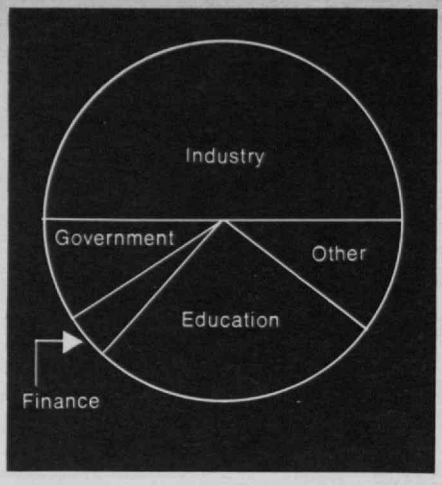
So Mr. Burmaster has organized a new branch of the program, under which students are beginning to find work in off-campus laboratories, hospitals, or industrial firms.

There are four ground rules: the work must be done during the school year (September to June); it must be worthy of academic credit; the student must meet regularly with two advisers, one on the M.I.T. faculty and another at the facility where the student is working; and pay can sometimes be substituted for academic credit, but the two can never be given simultaneously.

The new off-campus component is small (only 12 students have been placed since it began last September) but vigorous. For example, Carl M. Mikkelson, Jr., '75, is working at National Research Corporation on a computer design project which he began in high school; Norman H. Erenrich, '72, Steven K. Schuster, '72, and Seth M. Powsner, '74, are working at the Massachusetts General Hospital's Laboratory for Computer Science on uses of computers in the health care industry; and Alan S. Lawee, '73, is working at Bolt, Beranek, and Newman on computer graphic displays of models of organic molecules.

"The benefit goes both ways," Mr. Burmaster explains. "The student can work in an environment he might not be able to find on campus, and the firm gets high-quality research without having to pay for it."





A recent expansion of M.I.T.'s Visiting Committees will broaden the base of experience and viewpoint available to each M.I.T. department. Each of the 28 Visiting Committees will now include three members of the Corporation, six (instead of three) alumni, and six (instead of three) professional people nominated by the President of the Institute. With the new appointments completed, just half of the Visiting Committee members come from industry and 27 per cent from education; their average age is 52.

"External Linkages:" Expanding the Visiting Committees

A plan to increase the number—from 26 to 28—and the size—from nine to 15 members—of M.I.T.'s Visiting Committees was announced by Vincent A. Fulmer, S.M.'53, Vice President and Secretary of the Institute, at the national spring meeting of the American Chemical Society in Boston last month.

Outlining the benefits of M.I.T.'s Visiting Committee system for A.C.S. members, Mr. Fulmer said the Committees "represent a practical means by which the Institute seeks to draw upon a broad range of consulting advice from top-level sources outside M.I.T., and they constitute an important means through which the faculty test and promulgate their ideas." The increase in the committees' size, he said, "reflects M.I.T.'s desire to improve the performance of the committees and to broaden the base of advice available to each department."

The two new committees will be associated with M.I.T.'s efforts in the allied arts and with the newly established Department of Philosophy, Mr. Fulmer said. The traditional nine-member Visiting Committees have included three members of the M.I.T. Corporation, three alumni, and three professional members nominated by the President of the Institute. The new 15-member committees include six alumni and six professional members. As a result of the increase, the average age of Visiting Committee members has dropped from 56 to 52, Mr. Fulmer said, and the proportion of alumni on them has increased from 59 to 62 per cent.

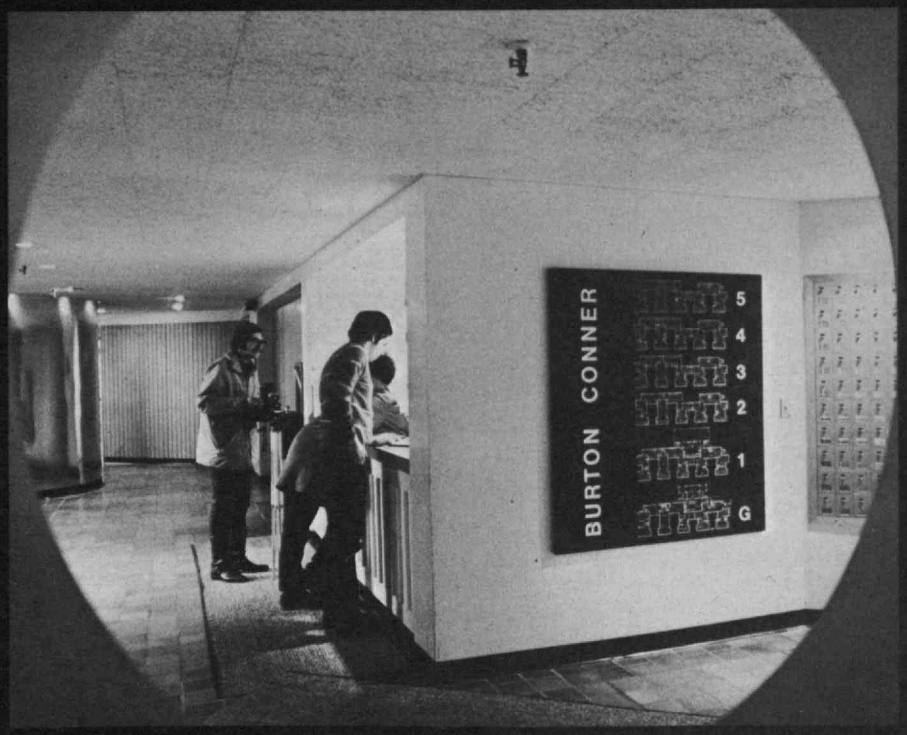
Reviewing M.I.T.'s experiences with Visiting Committees since they were first appointed in 1929, Mr. Fulmer listed two important contributions:

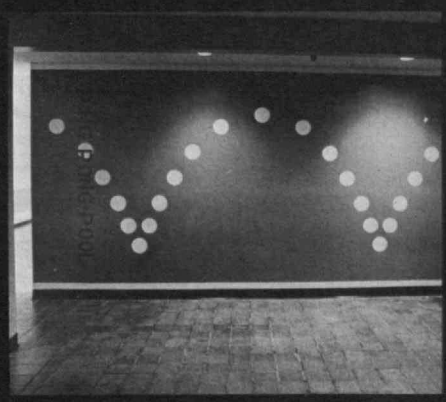
☐ To help members of the Corporation assure themselves that the academic programs of the departments are sound and in tune with the times. "They provide a systematic means by which trustees can keep themselves informed and better able to serve the interests of the particular discipline as well as the institution at large," he said.

☐ To bring a valuable stimulous from industry and the professions to the academic programs of the departments they serve. Indeed, said Mr. Fulmer, an important characteristic of an academic pacesetter "is that external linkages, which might be a luxury in some institutions, are an absolute necessity."

Meetings of M.I.T. Visiting Committees are closed and reports are privileged. But those who attend the meetings, said Mr. Fulmer, "realize that the scope and direction of a whole department are being laid open to inspection and discussion in the presence of senior officers and trustees. The give-and-take of these sessions . . . will rarely be dull, rarely without profound significance for the individuals whose professional development is at stake, and always . . . (represent) a steady stream of comment and experience flowing two ways between industry and the academic community."

The Gallery





When Burton House re-opened last September after a fifteen-month, $5 million reconstruction project, it jumped from near the bottom to near the top of the popularity list. Gone are the days of grim corridors and walk-through doubles; the new Burton is arranged in suites, each with its own kitchen, lounge, and bathroom. Some are even built on two levels with private stairways.

As luxury went up, capacity went down from 525 to 344. The total includes 34 women who live (segregated) on the fourth floor of the Connor section and the 20-person Russian House which is tucked away within the building. (Russian House includes 16 men and 4 women.)

The most modern part of the old Burton had been the dining hall, built in 1960 as an addition. But now that stands empty and unused. Kenneth C. Browning, '66, Assistant Dean for Student Affairs, explains that it was closed because of the new voluntary commons program and rising operating costs. The "small minority" of Burton residents who remain on commons dine in Baker or McGregor. The popular alternative to commons is cooking for one's self. Mr. Browning reports that "utility bills indicate that the kitchens are getting plenty of use."

(Photos by David Tenenbaum, '74.)

Faculty Promotions

Promotion of 47 members of the M.I.T. faculty, effective July 1, has been announced by Paul E. Gray, '54, Chancellor of the Institute.

Included are the following:

School of Architecture and Planning:

Edward B. Allen, Nicholas P. Negroponte and Edward Pincus to Associate Professors in the Department of Architecture.

Richard C. Larson to Associate Professor in the Department of Urban Studies and Planning.

School of Engineering:

Jean F. Louis to Professor and Shaoul Ezekiel to Associate Professor in the Department of Aeronautics and Astronautics.

Adel F. Sarofim to Professor and Jack B. Howard to Associate Professor in the Department of Chemical Engineering.

Marvin L. Manheim and Fred Moavenzadeh to Professor; David C. Major and David H. Marks to Associate Professor in the Department of Civil Engineering.

William T. Peake to Professor and Jonathan Allen, William L. Henke, Roger G. Mark and Albert Meyer to Associate Professor in the Department of Electrical Engineering.

Padmakar P. Lele and Robert E. Stickney to Professor; Richard F. Salant to Associate Professor in the Department of Mechanical Engineering.

Roy Kaplow, Robert M. Rose and August F. Witt to Professor; Keith H. Johnson and David J. Sellmyer to Associate Professor in the Department of Metallurgy and Materials Science.

Alaa E. Mansour to Associate Professor in the Department of Ocean Engineering.

School of Humanities and Social Science:

Robert W. Crandall to Associate Professor in the Department of Economics.

Albert R. Gurney, Jr., and Theodore Wood, Jr. to Professor; John L. Buttrick and John Harbison to Associate Professor in the Department of Humanities.

Nazli Choucri Field to Associate Professor in the Department of Political Science.

Emilio Bizzi, Alan Hein and Whitman A. Richards to Professor in the Department of Psychology.

School of Science:

David Baltimore and Ethan R. Signer to Professor in the Department of Biology.

Roger G. Burns to Professor and John S. Lewis to Associate Professor in the Department of Earth and Planetary Sciences.

Richard M. Dudley and Harold M. Stark to Professor in the Department of Mathematics.

Robert C. Beardsley to Associate Professor in the Department of Meteorology.

Hale Bradt to Professor; Eric R. Cosman and Roman W. Jackiw to Associate Professor in the Department of Physics.

Sloan School of Management:

George F. Farris, William A. Martin, D. Quinn Mills and Myron Scholes to Associate Professor of Management.

Alumni Calendar

Baltimore—May 18, Thursday, 6:00 p.m. —Joint dinner meeting, Engineering Society of Baltimore. Speaker: Barbara Mikulasi, Baltimore City Councilwoman. Topic: Women's Role in Politics.

Boston—May 11, Thursday, 12:15 p.m.— Luncheon meeting, Aquarium Restaurant. Speaker: Professor Ross H. Smith, Director of Athletics. Topic: Athletes and Athletics at M.I.T.

Chicago—May 12, Friday, 6:00 p.m.— Tour of Weston particle accelerator with dinner and lecture following.

Cleveland—May 11, Thursday, 6:00 p.m. —Dinner meeting, Cleveland Skating Club Restaurant. Guest of Honor: Paul E. Gray, '54, Chancellor.

Dedham—May 20, Saturday, 6:30 p.m.— M.I.T. Alumnae's annual meeting with Jerome B. Wiesner as guest of honor.

R. A. Kraay

E. R. Berlekamp

R. P. Simmons

Long Island—May 12, Friday, 6:45 p.m.—Dinner meeting, Lorrain Murphy's Restaurant, Manhasset. Speaker: Alfred A. H. Keil, Dean of School of Engineering.

Northern New Jersey—May 2, Tuesday, 6:30 p.m.—Dinner meeting, Marriott Motor Hotel, Saddle Brook. Guest of honor: Jerome B. Wiesner.

Seattle—May 3, Wednesday, 6:00 p.m.—Joint M.I.T.-Wellesley meeting, Eames Theatre of the Pacific Science Center. Guest of honor: Mrs. Ruth Adams, President of Wellesley College.

Individuals Noteworthy

To **Robert H. Park,** '23 and **Yu Hsiu Ku,** '25, The I.E.E.E. Lamma Medal . . . to **Jay W. Forrester,** S.M.'45, the I.E.E.E. Medal of Honor . . . to **MacElwyn Van Valkenburg,** S.M.'46, the I.E.E.E. Education Medal . . . to **John F. Elliott,** Sc.D.'49, the American Institute of Mining, Metallurgical and Petroleum's Albert E. White Distinguished Teacher Award . . . to **K. Uno Ingard,** Ph.D.'50, Professor of Aeronautics and Astronautics and of Physics at M.I.T., the John Ericsson Medal of the American Society of Swedish Engineers . . . to **John G. King,** '50, the Danforth Foundation's 1971 E. Harris Harbison Award for Gifted Teaching . . . to **Robert A. Kraay,** S.M.'57, the Missouri Honor Award for Distinguished Service in Engineering . . . to **Hamish N. Munro,** M.I.T. Professor of Physiological Chemistry, an Outstanding Teaching Award from the Department's students . . . to **Elwyn R. Berlekamp,** '62, the 1971 Eta Kappa Nu Recognition Award . . . to **G. David Forney, Jr.,** Sc.D.'65, the I.E.E.E. Browder J. Thompson Memorial Prize . . . to **C. Allin Cornell,** Associate Professor of Civil Engineering, the Walter L. Huber Research Prize of the American Society of Civil Engineers . . . to **Fred Moavenzadeh,** Associate Professor of Civil Engineering, the Stanford E. Thompson Award of the American Society for Testing and Materials . . . to **Silvio Vitalie,** M.I.T. Assistant Professor of Physical Education, the "Master Sword" Award, from the New England Fencing Association.

Elected to Fellows of I.E.E.E.: **Herbert C. Roters,** '30; **Isaac M. Horowitz,** '48; **Bernard M. Gordon,** S.M.'49; **Amar G. Bose,** '51; **Thomas E. Stern,** '52; **Paul E. Gray,** '54; **Elwyn R. Berlekamp,** '62; and **John B. Lewis,** Ph.D.'71. . . . 1972-73 Alfred P. Sloan Fellows: **Philip R. Sayre,** '54; **Charles C. Vicary,** '58; **William J. Towle,** '59 and **William R. Schonbein,** '62 . . . **Reginald E. Newell,** Sc.D.'60, Professor of Meteorology, to Fellow of the American Meteorological Society.

M.I.T. appointments: **Ross H. Smith,** Director of Athletics at M.I.T., to President of the Eastern Athletic Conference. . . **Haig G. Gechijian,** '48, Associate Director of General Services at MITRE Corp., to Deputy Superintendent of Buildings . . . **Thomas E. Shepherd, Jr.,** '50, to Superintendent of Utilities . . . **Whitman A. Richards,** '53, to Professor, Department of Psychology, formerly Associate Professor . . . **William H. Combs,** '54, to Superintendent of Buildings . . . **Arthur Krinitz,** '56, to Lincoln Laboratory Staff Member . . . **Charles E. Miller,** S.M.'66, to Lecturer, Department of Electrical Engineering . . . **Amos Levin,** S.M.'69, to Assistant Professor, Department of Aeronautics and Astronautics.

Corporate appointments: **Edward C. Doyle,** '47, to President, Syracuse Electronics Corp. . . . **Richard P. Simmons,** '53, to Executive Vice President of Allegheny Ludlum Steel Corp. . . . **Richard E. Norwood,** '56, to Senior Engineer, I.B.M.'s Systems Development Division Laboratory . . . **Norman C. Napier, 3rd,** '60, to Chairman of the Board, Engineering Computer Systems, Inc.

Deceased

Chester A. Hoefer, '06, March 15, 1972*
Howard J. C. MacDonald, '07, December 23, 1971
George S. Witmer, '09, February 3, 1972
Austin W. Brooks, '11, April 1971
Ethan A. Collier, '11, April 18, 1970
Alfred P. Morgen, '12, March 16, 1972
Charles T. Paugh, '16, April 12, 1971
James W. Anderson, '17, January 29, 1972
Barnett E. Dodge, '17, March 17, 1972*
Edward V. Pollard, '17, February 22, 1972*
Ralph H. Ross, '17, February 27, 1972
Edward Sidman, '18, March 8, 1972*
Pierre F. Lavedan, '20, March 18, 1972*
Douglas W. Coe, '21, January 12, 1972
Steve J. Seampos, '21, January 6, 1972*
Earl T. Heitschmidt, '22, February 26, 1972*
John V. Janes, '23, January 6, 1972
Arthur Kallet, '24, February 24, 1972*
Arthur W. Paulson, '25, December 1, 1971
Emil Kolisch, '26, February 21, 1972
Flint Taylor, '26, August 30, 1971
Edward E. Dobbins, '27, February 5, 1972
George A. Flynn, '28, December 16, 1971
Henry R. Childs, '29, October 18, 1971
Edward M. Heffernan, '31, January 30, 1972
W. Otto Bussenius, '32, July 15, 1971
William A. Shaw, '32, October 13, 1970
John H. Spiller, '33, June 29, 1971
Wilbur R. Nordos, '34, March 14, 1972
Robert Leventhal, '36, March 8, 1972
Stephen M. MacNeille, '37, March 23, 1972
Robert C. Whittingham, '39, January 15, 1971
Warren B. Christie, '42, September 15, 1971
William J. Cain, '43, November 2, 1970
E. Charlton Crocker, '43, February 25, 1972
Charles S. Jones, Jr., '43, December 30, 1971
Guy B. Stearns, '43, December 9, 1970
Allen E. Cox, '44, April 22, 1971
John J. Flynn, '49, December 10, 1971
Benjamin H. Downs, '50, February 14, 1972
Marvin E. Murphy, '50, January 20, 1972
William Carmack, '51, January 29, 1972
Herman K. Wiskind, '52, March 22, 1970
Benjamin J. Dasher, '52, December 13, 1971
Frank J. O'Neil, '52, October 3, 1971
E. Capen Farmer, '53, October 3, 1968
Haller van Bergen-Henegouwen, '55, November 28, 1971
Elmer J. Carter, '58, August 2, 1971
*Further information in Class Review

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Class Review

94

Still busy with his theories and inventions, **Charles Greeley Abbot** will observe his 100th birthday this month. A recent article in the *Wall Street Journal* ("A Scientist and a Sage Looks into the Future") tells of Mr. Abbot's long career in science and the great dream that has become the focus of his work, that of producing "big power, zero pollution" by turning sunlight to electricity.

What was to become U.S. patent No. 3,376,165 started as a dream Mr. Abbot had one night in July, 1965, when he awoke to find "he had been dreaming about something that hadn't even been invented yet. So he invented it. Then he went back to sleep."

According to the article, Mr. Abbot finds that some of his best ideas come as dreams in the middle of the night. "This night he awoke to see, with perfect clarity, just how one might build a solar boiler and turn sunlight to electricity on a commercial scale."

The device, which Mr. Abbot believes can produce power more cheaply than other solar energy programs, would use mirrors to concentrate solar energy inside a series of air chambers, superheating and circulating the air something like steam inside a steam engine. This moving air could then be harnessed for electricity.

Mr. Abbot believes his invention will revolutionize power generation. As of November, 1971, he was working on a scientific paper—his 175th—which will deal with the subject. "The device would work best," the *Wall Street Journal* notes, "in some of the very areas of the world that need cheap power the most—sunny, relatively cloudless areas in the tropics. And Mr. Abbot sees no reason it couldn't be harnessed for additional tasks like distilling water for irrigation. His big goal now is to find someone who will build a prototype."

For over 70 years Charles Abbot's work has helped to revolutionize the field of astrophysics.

Mr. Abbot retired as Secretary of the Smithsonian Institution 27 years ago—but he never really retired. His work continues: he still visits his office at the Smithsonian and is still as enthusiastic as ever about his theories, his inventions, and his dreams.—*K.S.*

96

The Art Center in Brockton, Mass., was established through the generosity of **Myron Fuller** '96. The director reports a growth in their "rent-a-picture" program which allows anyone to borrow original art work for a very small fee. The Art Workshops have introduced a course in photography this year and hope to install a potter's wheel and a kiln for ceramic work. Local schools and colleges as well as the people in surrounding communities are utilizing and supporting this unique center.—**Clare Driscoll,** Acting Secretary, 2032 Belmont Rd. N. W., Washington, D.C. 20009

98

Congratulations and best wishes to **Alvan Davis** whose 97th birthday is May 11. No one can beat that!

Looking back to May 1890, the issue of *The Tech* had a column about the steps of the Rogers Building—bringing up recollections. "Of all pleasant lounging places, there is no pleasanter one than the Rogers Building steps on a sunny day. All types of students appear there when the air is still, and the sun is high in the south. Some stand in groups, others sit upon the window ledges on each side of the door, while still more stretch at full length on the warm granite balustrades. The hard-working architect steals away from his drawing board and gothic arches to sun himself, and to think longingly of his summer vacation. Engineers talk in subdued terms of the coming exams."—**Mrs. Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

05

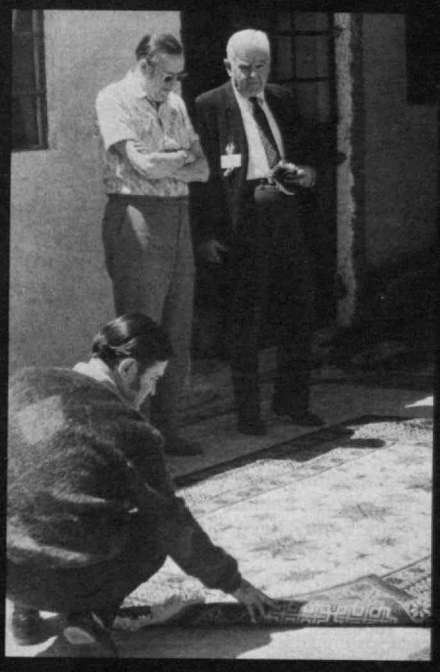
A week ago, not hearing any further news as to Grace and **Roy Allen**'s accident, I phoned, found Roy back at his apartment feeling weak and still aching and of course, trying to adjust to the loss of his wife. The next day I received a long letter, part of which I shall quote, "The accident was indeed catastrophic. We had had our car gone over, checked, lubricated and oil changed, ready for a little trip, and had gone to the bank preparatory to celebrating our 59th wedding anniversary the next day, February 5. Coming out of the bank parking lot I could not check the speed of the car to turn into the exit, but continued on at increasing speed for the back of the bank building. We knew nothing until aroused in St. Joseph Hospital, but were told later that the accelerator was stuck.

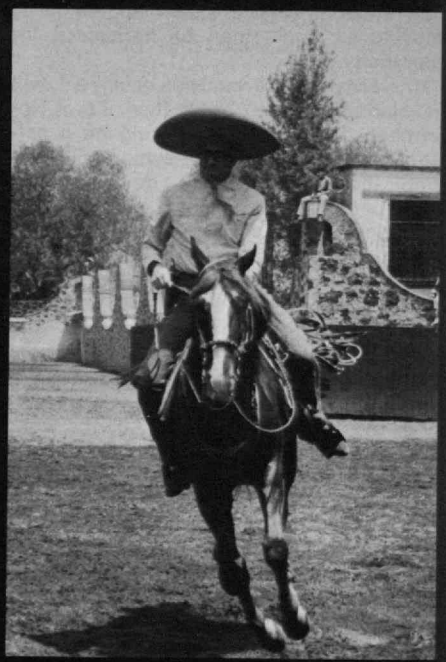
"Grace was terribly injured, and despite the best surgical and medical care obtainable, God took her after ten days in the intensive care unit. My nurse took me down daily to see her for ten minutes only.

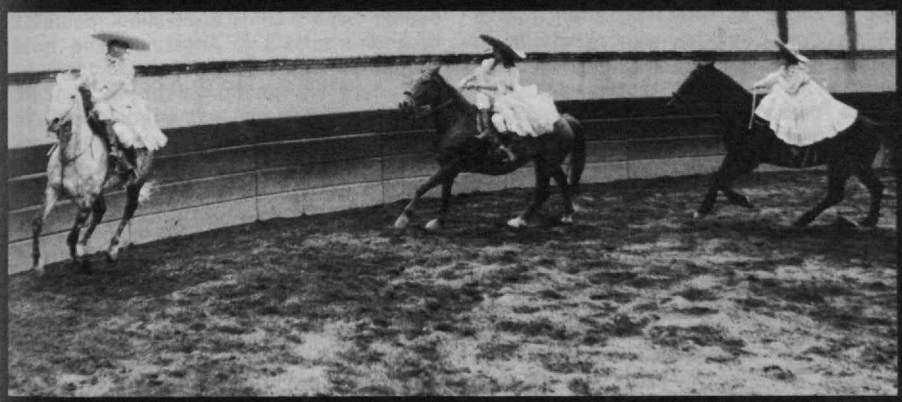
"My injuries were very minor compared with hers; only cuts and bruises, wrenched right arm, shoulder and back, and seven bruised ribs, six of them detached. After Grace's death I was taken to the Orangewood infirmary for recuperation, and kept there until March 6. I am now in our apartment, still stiff, sore, and very depressed, but am gaining. Cannot stop thinking of Grace and how terribly she was hurt. Safety belts are not a sure preventative."

Very little further news, so again I have to be personal. Our five daughters, their husbands and children, a total of 23, gave us a 50th Wedding Anniversary reception here in Sandwich. Our friends say that it was a very beautiful affair. If you knew my kin you would certainly believe it. There were about 250 guests, travelling from ten different states, and 34 different communities. Along with other gifts, they gave us a trip to Bermuda, with funds to implement. We leave on May 2, returning May 7. Very appropriately we spent our honeymoon there in 1922. Fortunately we feel we are in sufficiently good health for the trip and expect to be back in time to plant my gardens.

I have a clipping from the *South Shore News,* showing a picture of Major General **Leonard W. Cronkhite, Jr.,** showing him in uniform congratulating an L.T.C. on his promotion. He is apparently a carbon copy of his father, facially at least. . . . A letter from **Lloyd Buell,** congratulating him on his 88th birthday, gives us a sample of his philosophy: "While I may have gloried a little bit on reaching 88 with powers of perception, locomotion, etc., your card reminds me that this is nothing unusual for the Class of 1905. At our age perhaps we send birthday greetings more gracefully than







The 24th renewal of the M.I.T. Club of Mexico's annual "fiesta" drew nearly 100 alumni and guests to a celebration of Mexican hospitality and culture which has become a tradition for M.I.T. graduates from north and south alike. It set an example which planners of next year's 25th fiesta will be hard-pressed to surmount.

The three-day event began on March 16 with a visit to Mexico City's beautiful Museum of Anthropology and History. At the top left of the opposite page, Mr. and Mrs. Breene M. Kerr, '51, admire the architecture from under the giant fountain in the courtyard. At the top left of this page (left to right) Donald P. Severance, '38, Warren H. Martell, Mr. Kerr, and Charles T. Abbott, '30, are among those listening to a lecture in the museum's Aztec hall. Then came the traditional luncheon, where (center right, opposite) Dean and Mrs. Irwin W. Sizer (at left) were guests of honor. Also at the head table were Clarence M. "Nish" Cornish, '24, honorary president of the M.I.T. Club of Mexico, Mrs. Cornish, and Mr. and Mrs. Severance.

The following day began with an excursion to the town of Temoaya in the State of Mexico (bottom left, opposite) where Otomi Indians are learning Persian techniques of rug-knotting in a government-sponsored project. At far left, Mr. Cornish joins two members of the project admiring the workmanship.

On Friday M.I.T. alumni were the guests of Mrs. Estela Mora de Albarran for luncheon at Hacienda "La Gavia", *a splendid colonial monument (bottom, this page). There were delicious hot* hors d'oeuvres *cooked in the open (top right). At top right of the opposite page, A. Raymond Brooks, '17, John A. Lunn, '17, and Ian M. Clark, '61, president of the M.I.T. Club of Mexico, relax after the luncheon. At bottom center, Mrs. Conchita Pearson ('23) stands before a precolumbian sculpture which is set into the old* hacienda's *wall.*

On the last afternoon, Paul Gerard, '35, was the host at a charreada, a traditional Mexican show of horsemanship (center, this page) in which he himself was a participant (opposite, bottom). After the show he relaxed with Mr. and Mrs. Carole A. Clarke, '21 (center, this page).

The last evening was the noche Mexicana, *a festive garden party at the home of Mr. and Mrs. Cornish replete with Mexican music and refreshments—including a* piñata *in the shape of an enormous beaver wearing a* sombrero *and carrying a slide rule.*

Plans have not yet been announced for next year's fiesta, but club members were hinting that the 25th would be the best yet. (Photos: O. Reid Ashe, '70)

we receive them. Prematurely but sincerely, congratulations on your 90th come July. If you want to put something in the notes—I spend 35 hours a week in connection with the accounting and other records of Black's Nursery." A copy of the ad of Black's Nursery reminds us that in spite of the cold, dismal outlook of this second day of spring, she must be just around the corner.

A recent letter from **Herman Eisele** tells us that on his recent birthday (90th) he was honored at a luncheon meeting of the Cleveland Rotary Club as the only surviving charter member. An additional reason for recognition was that he is number three in the length of membership of 15,000 Rotary Clubs in the world. He adds "I don't feel that I have done anything to deserve these honors, except that I have eaten about 3000 luncheons and listened to about 3000 speeches in my 62 years in Rotary; perhaps that should rate a medal." Here's hoping, Herman, that you will be number one and in good health. . . . I missed telling you that the baby of the Class, **Gilbert S. Tower** had his 87th birthday on February 15, 1972.—**Fred W. Goldthwait,** Secretary, Box 231, Center Sandwich, N.H. 03227; **William G. Ball,** Assistant Secretary, 631 Fordham Place, Bradenton, Fla. 33505

06

There is an old saying, I believe, that "no news" is "good news". If so, all my classmates must be "in the pink" because I have had "no news" from any of them for some months—the most recent was a letter from **Luther Bent** in January. So. please pick up your pen and tell us how and where you spent those winter months and what you will be doing this summer. Marion and I continued to keep in circulation and are still living in the house that we moved into over 55 years ago. We expect to attend Alumni Day on June 5 as usual and hope to start a short vacation soon after.

We regret that we have a death to report—that of **Chester Arthur Hoefer** on March 15, 1972, at the Longwood Towers in Brookline, where he and Ruth Ella had been living since 1950 or so. Mrs. Hoefer died a few months ago. Chester was a native of Illinois and graduated from the University of Illinois in 1905, with an engineering degree. He was with our class during senior year and then joined his father in Freeport, Ill., becoming chief engineer and secretary of The Hoefer Manufacturing Co., making machine tools, etc. He married Miss Burlingame in 1912 and they continued to live in Freeport until he retired by or before 1945, I Believe. By 1950 they soon moved to Boston to Longwood Towers. Through the years we have enjoyed chatting with the Hoefers at reunions and on Alumni Days. We have missed Chester the last few years when he was unable to attend. Not only was Chester successful in business but he was also active in civic affairs—a long, successful and rewarding life.—**Edward B. Rowe,** 11 Cushing Rd., Wellesley Hills, Mass. 02181

08

We have a detailed report from a classmate **Leo Loeb.** He was raised in a small town in Missouri and graduated from the University of Missouri in 1906. Desiring to obtain a degree in mechanical engineering he was advised to go to M.I.T. During the summer of 1907 he worked as a field clerk on the construction of the South Boston power plant of the Boston Railway System. With a college degree, he entered and graduated with the class of '08, and was surprised to learn how advanced many M.I.T. courses were. He graduated with the Class as a mechanical engineer. As we well-know jobs were scarce in 1908 as the result of the panic. However, Leo was offered the position of junior engineer in the newly formed Bureau of Mines working on fuel supplies for government agencies in Washington and the Norfolk area. This gave him experiences leading to his ambition to become a consulting engineer. His work subsequently included: Instructor in mechanical engineering at the Rensselaer Polytechnic Institute in Troy, N.Y.; Assistant Steam Engineer, Cambria Steel Co., Johnston, Pa.; Senior Engineer at the Naval Engineering Experiment Station, and later Professor of Marine Engineering at the Naval Engineering School, both in Annapolis, Md.

He received an attractive offer from a Philadelphia Coal Co., with operations in West Virginia and Pennsylvania as fuel engineer and later in charge of their power plant design and construction. This lead to work with Day and Zimmerman consulting engineers of Philadelphia where he worked on reports and on steam plant construction. In 1924 he was employed by a public utility holding company in New York as one of four vice presidents supervising utility properties in the middle west. Then he and an associate formed a utility management and engineering firm in New York under the name originally of, Loeb and Shaw, later changed to Loeb and Eames. Through the Depression of 1929 they were occupied with problems involving economic engineering, and he continued in this consulting capacity until 1968 when he suffered a slight coronary from which he has entirely recovered. His principal activity at present is an officer and director of the M.I.T. Alumni Center of New York and a member of the M.I.T. Development Committee.

We are sorry to report two deaths in the class. **Charlton D. Putnam,** of 5296 Grantland Dr., Dayton, Ohio on December 6, 1971, and **E. Russell Willson,** of 30 So. Oak St., Hinsdale, Ill. on February 6, 1972.—**Joseph W. Wattles,** Secretary, 26 Bullard Rd., Weston, Mass. 02193

09

We have received the following news from **Art Shaw** who, with Betty, has been spending the winter as usual at Longboat Key in Florida: "Betty and I are enjoying an unusually fine Florida winter weatherwise and we remain in good health. Sorry I have no particular news. We were glad recently to get a letter from **Henry Spencer** reporting his return from the hospital and recuperation at home."

Phil Chase, who was former chief electrical engineer for the Philadelphia Electric Company writes: "Theora and I were at the June 6 buffet and also Pops but saw no '09 men we knew. Spent summer and fall, as usual, at Kennebunk Beach, Maine. We both still drive and get about a bit, but *slower.* Recently served as best man at wedding of my nephew, Colonel Theodore W. Chase, at Ft. Meade. Last time was sixty years ago!"

We regret that it is necessary to report a number of recent deaths among our classmates. The following note was received from Esther Pardee Harper of Kern City, Calif., sister of **Harvey S. Pardee,** a graduate of Course VI: "I am writing in regard to my brother, Harvey S. Pardee, a member of the 1909 class of M.I.T. Mr. Pardee died on last June 15. For 16 years he had lived with me and his companionship was a great pleasure to me. His optimistic philosophy of life combined with his realistic outlook have always been a source of enjoyment to his many friends. For 46 years he carried on his practice of consulting engineer in Chicago. Always loyal to M.I.T. he transferred his membership from the Chicago club to the Southern California Club when he came to California to live permanently with me. Many times I accompanied him to their interesting meetings in and around Los Angeles." The note describes well Harvey's character and his career. He was born February 9, 1884, in Minneapolis and was graduated from the University of Minnesota prior to entering the Institute. In Course VI he had unusual ability in both classroom and laboratory, showed much independence and individuality in his solutions of electrical technical problems, and was always good natured. As another electrical engineer, your secretary met Harvey a few times and knew of his consulting work. We have written to Mrs. Harper expressing the sympathy of the class as well as our own.

The following obituary notices were received from the Alumni Office: **Burton H. St. John** died in August, 1970, at Wichita, Kan. He was born July 1, 1888, in Wichita and prepared at Fairmount College. As a student he was in Course V, Chemistry, and was a member of the Chemical Society. Our records show that he was employed by the Boeing Aircraft Co., Wichita, and lived there during his lifetime.

Charles W. Radford died December 12, 1971, at Fort Lauderdale, Florida. He was born September, 1886, in Oshkosh, Wis., and prepared at the Oshkosh State Normal School. As a student he was in Course I, Civil Engineering, and a member of the Civil Engineering Society and Wisconsin Club. He lived in Oshkosh and, according to our memory, he was very successful in the transportation business. He moved to Fort Lauderdale in 1966. In the March 1969 notes there was a message from Charlie stating that he was sending a contribution to Student Housing, and that they "live permanently in Fort Lauderdale, go to Wisconsin every summer", and that they travel much and at the time contemplated a Caribbean

cruise.

We were suprised and sorry to receive an announcement of the death of Professor **Elmo A. Robinson** on January 17 at Los Alamos, N.M. It was only a short time ago (see June 1971 Class Notes) that we told of Elmo's retirement as head of the Department of Philosophy at San Jose College. Later he became minister of the Universalist Church at Los Alamos. He had just published a most comprehensive book, *American Universalism* which gave an authoritative account of the Universalist religion in America, 1793-1961. Shortly thereafter he embarked on his first trip to Europe. It is unusual for an M.I.T. graduate to make religion his life work and it is greatly to Elmo's credit that he attained such high distinction in this field. He was born January 1, 1887, at Canandaigua, N.Y., and prepared at East High School, Rochester, N.Y. He took Course VII, Biology, and was a member and secretary-treasurer of the Biological Society. Most of his life was spent in California and New Mexico.—**Chester L. Dawes,** Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

11

During last summer I called on five classmates who live within easy driving distance. Since I became Secretary, I have kept a scrap book of all the clippings relating to classmates that have come my way. This gave me something to talk about and the boys and their wives seemed interested. If I feel up to it I'll make a few more calls the coming summer.

The first call I made was on Margaret and **Bob Morse** at their fine old home in Sandwich. We talked of their golden wedding reception which I had attended about six weeks before and Bob gave me a good picture of Margaret and him cutting the cake. He was made building committee chairman for an addition to the Glass Museum which is located across the street from his house. I had a letter from him in February which was very newsy but he admonished me not to publish its contents. I hope no one else who writes to me will be so modest.

One very hot day in August I drove out to Belmont to see Artemis and **Suren Stevens** who live upstairs in a large two family house that they bought 20 odd years ago. After an hour's interesting talk, Artemis served us huge dishes of angel cake with ice cream and strawberries. They are justly proud of their yard with its flowers, well-groomed shrubs and luxuriant grass. In a small garden they have a few tomato plants five feet tall that were full of ripening fruit.

Next on the list were Gertrude and **O. W. Stewart** who live in an old house that they bought in 1921 and moved into permanently when he retired. Besides the acres of blueberries he has a large vegetable garden and a number of fruit trees. The place has got to be too much for him and he lets out the blueberry patch. In addition to his farming and work as Alumni Fund Secretary for the Class he is a member of the Vestry of the local Episcopal Church and is interested in civic affairs. Last November O. W. suffered a congestive heart attack which put him in the hospital for a while. He is now home and doing well.

My last call was on **Morris Omansky.** We sat in my car under a tree near his home in Brookline and talked about what we had done over the years. Neither of us recalled our failures, if any. Anyway we had a pleasant hour and a half together.

Chester Pepper's wife Mildred passed away on February 22. . . . General **George C. Kenney** was enshrined in the Aviation Hall of Fame at Dayton, Ohio, on December 17.

We have news that **Frank Smith** of Honolulu, while visiting his daughter in Seattle last summer, fell and broke his left arm, which kept him in Seattle until fall. He is now back and has resumed his reading, eating and playing shuffleboard.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

Next month we shall gather at McCormick Hall on the campus to celebrate our 60th anniversary reunion. At this date in March, I have not received final figures of attendance from Al Davis but we are hoping for a large turnout. Remember the date, June 2.

Howard Cather writes that he and Betty spent five weeks on their usual winter vacation in Florida, this time on Siesta Key, Sarasota. He was pleased to find that there were some 50 people from Rochester, N.Y. living in the vicinity, so they were very busy visiting about. . . . **Jay Pratt** and Priscilla cut their Acapulco vacation to two months this year due to Jay's illness from which he has recovered. They returned to Chicago in March. . . . **"Mac" McCormack** wrote, sending more data about the Hartland N.B. covered bridge, the longest now standing. He says, "Not feeling so brisk, but still carrying on. Have sold my old house, here in West Medford, Mass., and expect to leave Massachusetts, as my lease expires on June 1. I hope, however, to make the reunion." . . . **Harold Mabbott** also sent me a clipping of a covered bridge in Tennessee which is being restored. He writes, "All is well with me, but doubt whether I can attend the reunion." . . . **Jesse Hakes** and Mary sent a card from Japan while on their 92-day cruise to the Orient, South Pacific and East Indies, returning this month. They were delighted to find Mrs. Randall Cremer as a fellow passenger. We quote, "Last night we drank a toast to M.I.T. 1912, and to you and the grand job you are doing." They expect to be back in time for the reunion.

Harold Mitchell reports that he and Mildred expect to attend the reunion. She has been having less difficulty in walking since her new hip joint was installed last year, and has been feeling much better. Mitch's prolonged difficulty with hepatitis has now cleared up. The Mitchells attended the meeting of the American Ornithologists' Union in Seattle last fall. With three wildlife refuges near Buffalo, Mitch has been kept busy trying to get the authorities to build their new airport in a different location where it will not be endangered by large flights of geese and swans. . . . **Chester Dows** writes that they have done little traveling of late, as his wife, Frances, has had considerable trouble in walking due to a flare-up of her old 1915 polio trouble She is now using a walker to get about and Chet has installed an electric stair climber, which makes it possible for her to get up and down stairs alone. Otherwise, both are in reasonably good health and are enjoying occasional auto trips into the country.

We have news that **Wallace Murray** is just returning from a six-week cruise to Spain, France, Holland and the British Isles. It is called "a spring garden trip", timed to be in each country when the gardens are at their best. Wally expects to be home in time to attend the reunion. . . . **Carl Rowley** wrote to notify me of the sudden passing of **Arch Eicher** from a heart attack on February 24, notice of which appeared in the previous issue of the *Review.* We are expecting to see the Rowleys at the reunion.

We are advised by **Al Davis** that his wife, Gertrude died peacefully on March 6, due to a heart condition which had developed quite recently. To you, Albion, the Class of 1912 joins with me in expressing our sorrow and sympathy in your great loss. . . . From his daughter, Priscilla, we have a letter stating that **Johnathan Noyes** was stricken with a heart attack on February 26, and was placed under intensive care in the hospital. His progress has since been satisfactory and it is hoped that his recuperation will continue. His address is McAllen General Hospital, McAllen, Texas 78501. We are sure that he would enjoy hearing from any of his classmates.

We expect to be home in April after a four-month vacation in Bradenton, Fla., and are looking forward to a large attendance at our reunion.—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

13

William R. Mattson automatically became President of the Class of 1913 following the death of **R. Charles Thompson.** Bill has agreed to serve until our 60th Reunion in 1973. A considerable amount of communication with the existing officers of the Class was conducted during the past few months. It was decided that Mattson should appoint **Charlotte Sage** as vice president and that he nominate **Francis H. Achard** as representative of 1931 on the Alumni Advisory Council to serve until our next regular class meeting in 1973. Both Charlotte and Frank have consented to our wishes.

A letter was received from **Thomas J. Lough:** "On February 23 at an M.I.T. Club of Detroit dinner, Paul E. Gray, Chancellor, discussed current issues and new directions at the Institute. It was an interesting and informative speech. I was the only representative of the Class of 1913 present and I believe the oldest

alumnus there. I report this to show that I am still ambulatory. It is doubtful, however, that I will be able to attend the 1973 Reunion. Genevieve and I send you and Roz our very best wishes."

When we talked to **Frank Achard,** he informed us that he married Mrs. Margaret Mall Richardson, Course IV, Class of 1922, M.I.T. They are living at 1235 Boylston Street, Newton Upper Falls, Mass. 02164. Congratulations to the Achards.

We have received a note and a newspaper clipping from Mrs. Ellie Lewis. She stated that our classmate, **Malcolm Lewis,** 1002 West Trinity Ave., Durham, N.C., passed away January 27, 1972. From the clipping: "A native of Dedham, Mass., he received a degree in engineering from M.I.T. Before his retirement a number of years ago he was associated with the Durham County Health Department and taught engineering at N.C. State College. Surviving is his wife, the former Ellie Hinson of Durham." A note of sympathy was sent to Mrs. Lewis.

We must report the deaths of two other classmates: **George A. Taylor,** 5733 S.W. 45th St., Portland, Ore. 97221, passed away October 24, 1971; Dr. **Paul V. Faragher,** 314 Sixth St., Oakmont, Penn. 15139, died January 20, 1972. Sympathy cards have been sent to the families.—**George Philip Capen,** Secretary and Treasurer; **Rosalind R. Capen,** Assistant Secretary, Granite Point Road, Biddeford, Me. 04005

14

Frank Atwood is one of several members of our class who has not retired. He wrote in March that he had recently built and sold several houses on his land on Martha's Vineyard. Frank mentioned also that one of his sons-in-law, a professor of architecture at the University of Oregon, spent one of his sabbaticals in Ghana as the architect for the Kaiser organization at Tema and the village around the Volta Dam and his latest sabbatical landed him in Nigeria, where they liked his U.S. style of teaching so well that they persuaded him to stay three years—the last two as dean of his department.

As that's all the news I'd received in mid-March when this note was written, I beg again, as I did in the January issue of the *Technology Review,* for letters that will make possible a good quota of news in later issues. To adapt a remark that's become familiar in connection with computers, "Nothing in—nothing out."

At the end of February, our class ranked sixth, among the classes out 50 or more years, in total gifts to the 1972 Alumni Fund, and eighth in percentage contributing. We've often done better in both respects, and there's still time to raise our standing before the fund year closes at the end of June. So if you haven't yet given, please do so as generously as you possibly can. Your help is urgently needed, and your gifts will be wisely used.—**Charles H. Chatfield,** Secretary and Class Agent, 177 Steele Rd., West Hartford, Conn. 06119

15

You'll be glad to hear the good news that after a long slow and hard recovery, the old Pirate is back on the job as healthy and happy as ever. Nice going, George, keep it up. . . . **Maurice Brandt** wrote from Salisbury, N.C., "Every month when I read our class notes I say 'The Secretary Supreme' and I mean it. Our class members who live near 'The Hub of the Universe' are fortunate to be able to get together. In reading your notes I like to imagine I am there with you all. My wife and I keep in good health, live a quiet life with occasional short trips. My business, which I largely direct, keeps me busy several hours per day, and I really enjoy this activity."

Mona and **Clive Lacy** enjoyed a nostalgic train ride at Disneyland, with their son Tom '43 and his wife. Tom is a fruitgrower down there.

If any of you, to whom we used to send postals on our annual Caribbean cruise did not get one this year, it was because writing on board the ship was difficult. We did not mean to neglect you!

Wayne Bradley spent the winter at Hollywood Beach, Fla., and is planning a big season for his Moosilaukee Inn, Warren, N.H. If any of you would like to enjoy a summer holiday at this delightful place (we've been there) contact Wayne at his new office, 679 Boylston St. Boston, Mass. 02116. You'd like it up there. . . . **Larry Quirk** spent the winter at San Diego, Calif., and will be back in time for our Annual Class Cocktail Party and Dinner at the M.I.T. Faculty Club, Cambridge, on the afternoon of Alumni Day, June 5. We'll be glad to see you Larry and a lot of you other fellows, too. Be sure to come.

Herbert I. Knowles died January 2, 1972, in Plymouth, Mass.—**Azel W. Mack,** Secretary, Apt. 26A, 100 Memorial Dr., Cambridge, Mass. 02142

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We have an opening greeting from our still-ski-prone president, **Ralph Fletcher:** "As June approaches so does the Annual Reunion of the best Class that ever graduated from the one and only prestigious Boston Tech on Boylston St. Our 56th reunion will be celebrated at the Chatham Bars Inn on June 6, 7 and 8—Tuesday, Wednesday and Thursday. Alumni Day is Monday, June 5. We already are anticipating the joy of seeing those many classmates who keep coming back. For many of us it is sort of like a fountain of youth. We arrive tired and listless and go away with a spirit and a special enthusiasm that stays with us for several months thereafter. In January I enjoyed my annual skiing on the Parsenn in Davos, Switzerland. In November, after attending the dedication at M.I.T. of **Jap Carr**'s indoor tennis courts, I had a visit with Mr. Bird, who designed and erected the tent which covered the indoor courts. He was good enough to design a tent for one of my quarries and it is working out very well. Sibyl joins me in sending our best wishes and we both are looking forward to seeing many of you in June."

Back in September, **Van Bush** received an Honorary Doctor of Engineering from Dartmouth College. Dartmouth's citation aptly referred to him as "an engineer who played a decisive role in shaping the events of the last half century." We especially liked the reference to the Van we know: "One of the busiest of human beings, you found time to develop an archer's superbow, raise turkeys, play the flute, design glass fishing rods, listen to birds sing, and contemplate the fundamental question of the role of the scientist in society." Congratulations again, Van!

Art Shuey of Shreveport, La., says he and Mildred hope to make an early July trip on the *Olympia* to see the total eclipse. . . . **Walt Wolfe** of Bradenton, Fla., speaking of days "way back when," notes that he has an excellent photograph, taken on Walker steps in May of 1916, of the small group of students comprising Course XIV and the two professors who headed the course—Goodwin and Thompson. "There are only three of us left now: **Harry Smith, Chet Richardson** and myself." Further: "You may never have heard of Course XIV (electrochemistry) or at most only casually. It was a broad course and its very broadness insured it would be difficult. We certainly had no time for such incredible, senseless, sickening acts as breaking down Institute doors or tearing up the carpet in the President's office."

Emory Kemp sends word from Sarasota, Fla., where he and Ruth keep in contact with a number of Boylston St., graduates. They keep in touch regularly with Bill and Peg Ball. Bill is Assistant Secretary of the Class of 1905. Emory says the new roster of their M.I.T. Alumni Club of Southwest Florida indicates that the Sarasota area alone has about 150 possible members. And the Club includes the following 16ers: **Ralph Forsyth, Frank Ross, Elmer Wanamaker, Andrew Witherspoon** and **Walt Wolfe.** The **Don Websters** are in Sarasota too, until April 15. As he tells all about it, Emory seems to be saying, "Come on down!"

Charlie Lawrance passes on some philosophy for younger Tech graduates: "Take every possible opportunity to travel and enjoy life as you go along in your younger years. Never put off any special trip or event to the time when you 'retire.' By then you may not have the strength or the means. 'Do it now' is a good lifetime aim and motto!" He's following his own advice for he's always younger than he will be next year. He and Lois are two more who are looking forward to the 56th reunion in June. . . . Back in February **Cy Guething** wrote from Delray Beach, Fla., where he and Gyps spent a month or two probably to avoid shoveling snow back in Birmingham, Mich. Cy said then he was well along to being a salted-down codfish with two applications a day. To top it off he had located a seafood restaurant where they could afford (Hm! that's what he said) to eat lunch—opened oysters and conch chowder or cherry-stone clams. They were looking forward to Boothbay Harbor, Maine, where he plants himself "in one of those excursion boat chairs

every pleasant day, just enjoying the motion of the sea and the fishing each weekend given me by the bankers who want me along to charge it off."

Ken Sully and Emerald have now lived in Laguna Hills Leisure World six years, where construction has now started on the final phase. Says "When completed there'll be 21,000 living here. We think this is the finest retirement community anywhere." . . . In February, **Francis Stern** reported a cool winter in Palm Springs, "very few bathing days—in two months, only eight or nine. Today it even rained a bit. I manage golf however. It's so long since I've had two pars in succession, I've forgotten how to count."

Will Wylde, wintering as usual in El Rancho Village, Bradenton, Fla., extols some advantages of their winter spot, as he and Ann have news of the arrival of their second great-grandchild. "We are fortunate to live in a park here where automobile traffic is held to a 10-mile-an-hour pace and people walking or riding bicycles are given the right of way. Accordingly, Ann on her tricycle and I on my bike often take advantage of that exercise. We also play quite a bit of very bad golf on a course that adjoins us here." . . . **Charlie Cellarius** keeps on the move—to England in September and "leaving Port Everglades in February for a cruise on the S.S. *Hanseatic* through the Caribbean Islands. When that finishes I shall spend two weeks on the British island of Barbados." . . . **George Spooner** of Denver notes that he has a son, a chemical engineer in La Grande, Ore., and a daughter, son-in-law and four granddaughters in Lakewood, Colo. His daughter is a registered nurse—a Minnesota graduate.

We regret to report the death of **Ed Clarkson** in Oakland, Calif., on January 15. He taught civil engineering at Tech for a year after graduation, then a year in the army and a year with the Rockefeller Foundation on malaria control in south Arkansas. From there he moved to California where he engaged in civil engineering work including irrigation projects and was for some 28 years in the Department of Public Works, City of Los Angeles, retiring in 1953. His daughter, Pat Clarkson Welch, writes that he left an incomplete record of the distribution of his paintings. If you have any information about this—location and subject—let her know at 1020 Oxford St. Berkeley, Calif. 94707, for it will help her complete a catalog of his works.

Henry Shepard and Frances had another pleasant summer in Randolph, N.H., hiking and swimming, with old car meets from time to time in which he "managed to win two more prizes with his 1913 Chalmers. The car is now stored for the winter in a warm garage. I now have the air starter operating after making a water-cooled valve for the no. one cylinder. We were invited to the formal opening of Jap Carr's inflated tennis court at M.I.T. The high point of the party was an exhibition match put on by Jap and his son with two professionals. Jap got most of the applause. . . . **Ed Barry** now lives in nearby Sherborn and has joined our Newton Retired Men's Club. He looks very well and is enjoying retired life."

Dick Hunneman sent an opinion of his published in the *Boston Herald Traveler,* October 18, 1971,—a sad comment on human fallibility:—"Fifty-three years still does not dim the memories of many World War I veterans of the desperate, hopeless, exhausting, and bloody fighting of October 1918, which surprisingly led to the armistice at a cost however of 110,000 American casualties in 40 days; an achievement which the Allies were subsequently to have the contemptible insanity to abandon with the whimsical disregard of an inconvenient nuisance, to their ultimate costly and inevitable regret. Future generations who find fault in minor ways with the establishment the world over, should realize that they have a legitimate gripe in the infamous and fatal discontinuity of thinking that followed World War I."

From south of San Francisco **Lev Lawrason** writes of a happy and satisfying retirement, "I am still living in the Seal Beach Leisure World—seven years now. I have been on our Mutual Board for the last two years and that gives me something to do. We are near the ocean and the smog is not at all bad. I got a four-year renewal on my driver's license so I can continue to visit my two daughters in San Diego and West Los Angeles. Am still able to work in their gardens which I enjoy very much. I still maintain a small interest in a Chemical Co. which I helped found 40 years ago. This plant is located about 15 miles from here. I have three grandchildren in the local colleges."

Jack Burbank in Marstons Mills, Cape Cod, describes the kinds of flowers and plants he spends his time with a few hours a week in his greenhouse during the winter months: geraniums, golden freezias, camellias. He cut one of his own small white pines for a Christmas tree and says: "I plant 10 to 25 10-inch seedlings of various evergreens on my four and a half acres. The life of the native Cape Cod pines is limited to 30 years, plus or minus, depending on windstorms—and they are brittle."

Once again, we'll say—see you soon down at Chatham Bars Inn for another of our wonderful reunions. In the meantime, keep writing, just a bit but often, to keep the little old column full and interesting and to keep your secretaries from getting lazy!—**Harold F. Dodge,** Secretary, 96 Briarcliff Rd., Mountain Lakes, N.J. 07046; **Leonard Stone,** Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

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By the time you read this you will have received a summing-up letter from reunion chairman **Tubby Strout** so this is about the last call. There will be room at the Chatham Bars Inn for any and all last minute deciders. A special letter invitation was sent to the class widows to attend and we are hoping that a good number will join us under the hostessing of **Vi Proctor.**

Dick Logan and **Brick Dunham** sat side by side in Professor Haven's lectures in his theory of structures course. He used the term "incipient crack" so, often that the two budding engineers dotted their notes each time and got quite a collection of dots. In correspondence recently Dick advised Brick of his limited activity due to an "incipient crack" in his motor.

Al Lunn has just returned from Mexico City where he was given the Eagerissimo Beaver Award for attending his tenth Fiesta and **Ray Brooks** received the Eager Beaver for his fourth Fiesta. Others who enjoyed the fine affair were Conhita Pearson, Alice and **Will Neuberg,** and Ruth and **Bill Dennen** for their 16th time, all of whom will attend our 55th. . . . Our assistant secretary reports that a change has been made in the location of the '16-'17 monthly lunches. The March meeting was held at the quarters of the Dartmouth-Brown Clubs at the Commodore Hotel, N.Y., with Dick the only '17er present.

It is good to have word from **Al Moody** that after a couple of operations he is now in pretty good condition and getting along fine. . . . On February 26 Vi Proctor attended a ceremony at the Chilton Memorial Hospital in Pompton Plains, N.J., where Dix had been a trustee and Vi is a Pink Lady. A plaque for Dix was unveiled which read, "In acknowledgement, and to express our gratification of his services to and interest in Chilton, we are dedicating the Coronary Care Unit in his memory." . . . You will recall the notes' mention of **P. Y. Hu**'s grandson Chi Kwan entering M.I.T. in 1967. He graduated last June and is now pursuing his M.S. degree. Chi deserves much credit, first facing the language barrier and then working every vacation and holiday.

Al Ferretti has thoughtfully forwarded word of the death of **Edward V. Pollard** in Cincinnati in February. He had retired from General Electric after 44 years and had been in poor health for a long time. Ed and Al had gone through school together from primary through M.I.T. . . . From Haig Solakian and John DeBell comes word without detail of the death of **Barnett F. Dodge** in New Haven, Conn., on March 17.—**Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass., 02174, **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

18

One of the rewards of being an M.I.T. alumnus is the feeling that you are part of the M.I.T. family—and particularly of your Class. Within the past few weeks **Bill Foster** came to the campus for the day. I was not at the office or the house when he called and so he and Selma had a nice chat over the phone. Despite the fact that Bill and I have met but once to my knowledge—our correspondence, and the news recorded in the *Technology Review*—all this has made us feel close to each other. And all you 18'ers—the latch string is always out at 60 Longwood Ave. Come any time.

Here is news from **George Woodruff,** "The time I spent at M.I.T. was so brief, there was little or no opportunity to meet many of my fellow students. I took a

special course and did not graduate. I left to enter World War I in the Medical Corps. I am now retired, will be 77 and live in Atlanta where I maintain an office. After the war I was connected with the following businesses: steel, ice manufacturing, motor trucks, and cotton machinery. Presently I am an active director for several other companies with retirement age limits. Also serve as trustee of several educational institutions and foundations. I still have plenty to do here at the office, but when time permits, my recreation is on the golf course.

"Mrs. Woodruff and I celebrate our 54th wedding anniversary in April. We have three daughters, seven grandchildren and two great-grandchildren. Prior to entering M.I.T. in the fall of 1917, I attended Georgia Tech. I now serve as trustee emeritus of the Georgia Tech Foundation. Congratulations for your continued interest in the number one technological school in the nation."

Horace Guilbert writes regarding the reunion last fall and adds "My wife and I spent the summer months in Dedham, and have long wanted to have a look at Endicott House. The high spots in my career are these. From our junior year I went into the U.S. Army Air Service; ground school at M.I.T., flight training at Minneola and in France, then over a year in the First Aero squadron, at the front from May to the Armistice, there to Coblenz in the Army of Occupation. After returning to the U.S. I was commanding officer of a squadron on the border and became a civilian again in October 1939.

"After a couple of years in Dayton, Ohio I returned to the northeast and was with the B.F. Sturtevant Co., in Hyde Park until 1949, when my first wife and I moved to Tryon. We went into business together, making modern toys which we retailed in our own salesroom, and were making a good living when my wife passed away in 1957. Since then I have continued with the help of a paid decorator and since marrying again in 1968 I work only from September to May. It has been an interesting occupation which pays the taxes and helps to keep me young.

"**John Poteat** and I are permanent year-around residents of Tryon; he and I frequently appear at parties in our 50th reunion crimson blazers."

We have a note from **Frank Wells.** "My main activity right now is reading textbooks into a tape recorder for blind students. I discovered that some of the probability math was unreadable and even various graduate students at A.M.P. were unable to help me find the words in which to describe the operations and all science dictionaries were way out of date. At present I am dictating the *Pentagon Papers.* It's a rather embittering experience. I don't see any of our classmates here and at present I don't travel much but still read the class notes. Until I developed heart trouble I was making yearly trips to Europe. With luck I may be able to do that again."

I am very happy to include a newsy note from **Herbert R. Polleys.** "Your persuasive letters have several times brought me to start a sheet with 'Dear Max', along with a paragraph or two. Alas! that is where I have stopped. My life at Tech was marred by two major events: an unexpected illness which lasted a whole year, and World War I. I did however, finally complete about three years before trying to enlist in the army and navy. I finally went to work on a naval development project being carried out by the Gallaudet Air Craft Corp., at East Greenwich, R.I. I worked with this company on a hush-hush project for the development of a fast fighter seaplane. It was very interesting to see a new design concept carried through from the drawing board and finally through the successful navy tests.

"At the end of the war I married Gladys B. Poore of Exeter, N.H., whom I had met while a student at the Academy and left the aircraft company. I next went to work for the U.S. Rubber Co., as a development engineer at an experimental laboratory in New Haven, Conn. I stayed with the rubber company (now UniRoyal) mostly developing machinery for the industry. During World War II, I was assigned to work on aircraft, bullet-proofing fuel cells, chiefly developing and producing the destructible forms upon which they were built. Several plants were set up in the East and we turned out thousands to equip fighter and bomber planes.

"After the war I again carried out machine developing until retiring in 1960. Since that time I have been engaged in consulting work mostly in the Boston area. I lost a good friend when Barry Wills died: we used to play tennis. At rare intervals I have seen Sax Fletcher. Stew Boyd also worked for UniRoyal and I saw him frequently. Jack Wood and I went to the same technical school in Providence before entering Tech and we had much fun at S.A.E. with the first so-called dinghy, named 'Wampus,' which we often sailed around the Basin. At times I was part-owner and after buying out Jack, the boat was shipped down to Narragansett Bay. I believe the entire investment only cost about $25. For about seven months of the year my wife and I live at our country home in Brooklyn, Conn. Keep up the good work! Kindest regards."

Mal Baber sends this news including a clipping concerning Bill Wyer. "I can report that I am progressing steadily, although the process is a long one. Currently, I am under limited house arrest—permitted short walks and drives in good weather and am helping the firm by a modest amount of tax work at home. I get very little news, however, 1973 is still very much in my thoughts and plans."

The article Mal enclosed about **Bill Wyer** is part of a report to stockholders of Reading Co. "Your board of directors continues to give careful consideration to the affairs of the company and the interest in the stockholders. To this end we have retained on a monthly basis the services of Wyer, Dick and Co., of Newark, N.J., one of the few outstanding transportation consultants in the country. We believe their advise may be of incalculable value in the days to come in charting a course for the company."

It is with sadness that I reveal the passing of one of our classmates. The *Boston Globe* reports, **"Edward Sidman,** 74, of 32 Parkway Rd., Brookline, retired executive director of the Y.M.H.A.-Hecht House here, died yesterday in Beth Israel Hospital following a brief illness. Involved in Jewish and non-sectarian social work during most of his adult life, Mr. Sidman began his career as a mechanical engineer. In 1918 he graduated from M.I.T. with a degree in mechanical engineering, and then studied electrical engineering at Lowell Institute. He later studied at Boston University's School of Social Work. Mr. Sidman first joined Hecht House, then on Beacon Hill, in 1921 as a volunteer leader of a teen-age club and a Boy Scout scoutmaster.

"In the early 1930s Mr. Sidman decided to leave the field of engineering and make social work his full-time occupation. In 1935 Hecht House moved to Dorchester, where Mr. Sidman's efforts helped develop various camp programs. He was named executive director of Hecht House in 1945.

"Since his retirement in 1961, he did some work for the Federal Department of Housing and Urban Development and as a consultant for various programs. He was a charter member of the National Association of Social Workers and of the Academy of Certified Social Workers; and an active member of many other community organizations. Mr. Sidman leaves his wife, Bella, a daughter, Mrs. Marion Blank, a brother, Manuel, and a sister, Mrs. Esther Kramer."

Harold Weber's new address is 10439 Kingswood Circle, Sun City, Ariz. 85351.—**Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard I. Levine,** Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

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Dr. **Louis Wolff** who won fame in 1930 when with Dr. Paul Dudley White and Sir John Parkinson he described a heart condition now known as Wolff-Parkinson-White syndrome, died January 28, 1972, in Beth Israel Hospital in Boston after a long illness. He was a past president of the New England Cardiovascular Society and was Clinical Professor of Medicine Emeritus at Harvard Medical School. He resided in Brookline, Mass.

Lloyd R. Sorenson writes: "Winnie and I were going to Greece to a small shipyard to act as a shipbuilding and repair advisor under assignment of the I.E.S.C. This would have been our fourth assignment. We had two (for one year) in Singapore and one (for four months) in Colombia, S.A. On a check-up just before leaving, the doctor found an irregularity in my heartbeat, so this trip has been postponed for the time being."

Frank P. Reynolds passed away in Venice, Fla., on January 29, 1972.

Your secretary wishes the Class a pleasant summer and will be in Washington, D.C. from June 15 to October 15. —**Eugene R. Smoley,** Secretary, 50 East Rd., Delray Beach, Fla. 33444

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A note from **Lee Thomas** offers the news that **K. B. White** has been on one of those African animal viewing safaris and had a great time. Tell us more about it K. B. Florence and Lee visited six countries in Europe late last year, surveying management techniques in various plants. Lee observes that marketing seems to follow the pattern of American parent companies but labor relations, production and engineering follow the customs of each country.

Al Wason of 16 Kenilworth Circle, Wellesley, Mass., reports that he is keeping active and interested by maintaining a lively association with retired men's clubs of Needham and Newton participating in such off-shoots as the camera, bridge and investment activities and says Al, making many wonderful friends. Knowing you, Al, we can well believe it.

It is with a heavy heart that I must announce the death, in March, of our beloved and admired **Pete Lavedan.** Pete had been in precarious health for some time but never lost that sparkling humor that endeared him to us all. Since his retirement he had lived at Old Mill Point on Cape Cod. Born in Paris, he came to New Orleans where he attended schools before coming to M.I.T. He served as Chairman of the Board of Liquid Carbonic Corp., was national President of Phi Kappa Beta fraternity and General Chairman of the Harwich Anniversary Committee, a member of the Cape Cod Chamber of Commerce and a past president of the Natural Compressed Gas Association. He leaves his wife, Catherine, a son Pierre, Jr., of Houston, Texas, and two daughters. We are thankful that many of us had an opportunity to visit with Pete and Kay during our 50th Reunion. I am sure I speak for all of us in expressing deepest sympathy to the family. Pete was one of the most illustrious and most popular members of the Class and his loss will be keenly felt by us all.

Karl Bean of 55 Early Red Berry Lane, Yarmouthport, Mass., thoughtfully contributes this additional information about **Pete Lavedan** as we go to press. Pete had been a summer resident of Cape Cod since 1916. He was a member of the Cape Cod Viewfinders Club and the Shakespearean Study and Reflection Club of West Harwich. (Readers of these notes may recall that this high sounding group of males was the tongue-in-cheek pseudonym for an ardent and congenial gathering of poker players). He was an honorary member of Tau Beta Phi and national president of Phi Kappa Theta. He also served as president of The Old Mill Point Association.

In his letter Karl also mentions that Mary and **Henry Massey** paid he and his wife, Agnes, a visit recently. Henry's address is Forest Branch Extension, South Orleans. The Beans moved to the Cape some four years ago to escape the rigors of winter in New Hampshire. They enjoy gardening, golf, and on those few occasions when winter keeps them indoors, bowling.—**Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

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Here it is May again and a month or less to Homecoming Day when many of us will be gathering for another minor reunion of our Class. From 3 p.m. Sunday June 4 until 6:30 p.m. Monday, June 5, M.I.T. has scheduled exhibits, International Buffet, Boston Pops, panel discussions, Alumni Day luncheon, and a Gala Soiree at 5 p.m. Monday. We hope to see you there.

The annual letter from our Class Estate Secretary **Edmund G. Farrand** stressing the need of M.I.T. for estate gifts, reminded us of the wonderful five-year class gift presented last June. M.I.T. is in a real budget squeeze, materially affecting scholarship funds that can be made available to needy students in these days of high college costs. For those that missed it, we commend the reading of "The $10 Million Gap" on p. 73 of the February *Review.* The Alumni Fund needs our continuing generous support.

Two fine letters from **John H. Driggs** of San Clemente, Calif., recall the guiding influence of Professor Schell on Course XV students. His senior year "Million Dollar Lecture" aroused great advance expectations in the students but proved to be a sermon on honesty in business and in the home, so that with spiritual guidance, the seniors could realize a million and much more. After graduation Professor Schell continued teaching to his students through letters, on new business ideas, economic trends, some philosophy and always a spiritual thought. A privately printed book mailed out by Schell had as an appendage a lecture delivered by Karl Compton in 1946 on "Why Religion." Said John Driggs, "Over the years most of us received our full share of the million." John entered M.I.T. in January 1919 and got married in 1920, which makes him a competitor of **Garvin Bawden** who also was married in 1920. Two years ago John and his wife celebrated their golden wedding anniversary. They travel to Switzerland every other year. Although living in San Clemente John has yet to see President Nixon. He writes that he enjoys reading many of the current articles in *Technology Review,* particularly those on environment, housing and transportation.

Dean Emeritus **James R. Cudworth** of the University of Alabama, College of Engineering, was honored by the American Institute of Mining Metallurgical and Petroleum Engineers Meeting in San Francisco; they awarded him the Erskine Ramsay Gold Metal for long and distinguished service in engineering education and the field of coal mining. Congratulations John! . . . A letter from Assistant Secretary, **Samuel Lunden** reports that he and Leila took a 12-day cruise to Mexico in February. Aboard a chartered fishing boat off Alcapulco their party of four brought in a 220-pound marlin and a nine-foot sailfish. Quoting Sam, "We rotated chairs and lines every half hour and the fish were always caught from the chair I just left!" Sam also enclosed the Town Hall Journal (of California) announcing that **John W. Barriger** was to address that body on the subject of "Government Regulation—Bankrupt Railroads." John doesn't pull any punches nor hesitate to give his prescription for curing sick railroads. The *New York Times* reported that the trustees of the Boston and Maine Railroad believe that bankrupt line can be saved. John Barriger is its C.E.O. Incidentally, John's residence is now Apt. 27E, 151 Tremont St., Boston, Mass. 02111.

Florida News

Edward W. Noyes of Nokomis, Fla., wrote that he was still another of our Class to travel to Alaska in 1971. "Our boat is all set for a trip to the Florida Keys and then the Bahamas after we return from a trip north in January to attend the marriage of one of our granddaughters. Am also learning to fly a Cessna Skyhawk." . . . **Glenn E. Fargo** of St. Petersburg, told of his sixth trip to Europe, visiting Germany, Switzerland, Spain and Portugal. . . . Another pair of travellers were Millie and **Herbert Kaufmann** of Sarasota, Fla., and Armonk, N.Y., who visited England and France last September. Herb reported that **Bob Felsenthal** of Westport, Conn., is working full-time as president of Exmet Corp.

A luncheon date at the Holiday Inn, in Punta Gorda, Fla., in February brought out Claudia and **Josh Crosby,** Marion and **Phil Payson,** Helen and **Mich Bawden,** Edna and **Phil Coffin,** Margaret and **Dick Windisch** and Betty and **Sumner Hayward.** It was a delightful affair. The Bawdens have bought an apartment in Naples, Fla., and are considering making this their permanent home. Helen Bawden reported that the 1921 class baby, Nancy Bawden Dithmar, born July 14, 1921 took part in her daughter Jill's wedding in June and later in her other daughter Jean's wedding in September.

Dick Windisch told of seeing Francis L. Blewer, senior partner, W. E. Burnet and Co., on the occasions when he gets up to New York. Dick was a partner in this firm for many years. . . . Seeing Phil Coffin reminded your secretary of an interesting plant-tour conducted by Phil during World War II at the Aluminum Co., plant in Queens, N.Y. A most unusual feature was the use of huge bus bars made of silver, loaned by the U.S. government. Copper was in short supply. Those bus bars, far from being silvery, were black from sulphur fumes in the air.

Claudia and Assistant Secretary, **Josh Crosby** were hosts at a wonderful party in February at their home in Sarasota. The party included the **Allen Addickses** from St. Petersburg, the **Helier Rodriguezes** from Tampa, the **Philip Paysons** from Fort Myers, the **Tom Duttons** and **Larcom Randalls,** from Sarasota and the **Haywards.** The Randalls spent last summer at their place on Lake Winnipesaukee and the Crosbys vacationed on the coast of Maine. . . . The day after the Crosbys' party, Madeline and **Ralph Shaw** were hosts to the Coffins, the Bawdens and Nancy Bawden Dithmar at the Pirates Den in Naples. The Shaws spent Thanksgiving at Sanibel Island, Fla., and visited Barbados, West Indies during February.

Other Florida visitors heard from were Win and class treasurer **Royal Wood** spending March in Sarasota and Anne and **Wallace Adams** who made plans to visit Delray Beach and Sarasota. Wally was re-elected to a third year as Senior Warden of his church and is continuing as president of the Planned Parenthood Association of Butler County, Ohio. He keeps fit physically with Boy Scout camp maintenance and golf.

A letter from **Leon A. Lloyd** of Westerly, R.I., tells of his selection by the Democratic Town Council to serve on a citizens group to study town re-evaluations. He is also deeply involved as a member of the pulpit committee in the time-consuming job of selecting a new Pastor. . . . Helen and **Robert F. Miller** of Silver Spring, Md., took a 14-day Caribbean cruise on the liner *Europa* in March, making stops at seven islands.

Sadly we report the death of three of our classmates and extend the sympathy of the Class to their families. **Steve J. Seampos** Brighton, Mass.; **John J. Collins,** North Hampton, N.H.; **Herbert W. Reinhard,** Newtonville, Mass. Your secretary had known Steve Seampos back to Brockton High School days. He was a fine chap. Ed Delaney attended the services for Herb Reinhard and supplied the information on the passing of both Collins and Reinhard. Herb died in Sao Paulo, Brazil while visiting his son, Reverend William T. A. Reinhard, an oblate priest stationed there.

Changes in address: Paul L. Hanson, 10399 67th Ave. N., Seminole, Fla. 33542; Walter A. Jayme, P.O. Box 741, Melville, N.Y. 11746; Joseph G. Kaufman, 16300 W-9 Mile Rd. #915, Southfield, Mich. 48075; Harry M. Ramsay, 1400 El Norte #112, San Marcos, Calif. 92069.

Your letters are wonderful and a joy to read. Keep them coming.—**Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary for Florida, 3310 Sheffield Circle, Sarasota, Fla., 33580; **Samuel E. Lunden,** Assistant Secretary for California, Lunden and Johnson, Arch., 453 South Spring St., Los Angeles, Calif. 90013

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In these "financially difficult times," as expressed in letters from the Institute, your Secretary was still able to join **Oscar Horovitz** in Pompano Beach at the James Whitmore presentation of "Will Rogers." We enjoyed visiting with Mary and Oscar hearing of their pleasant winter with daily golf in delightful surroundings. Oscar will take over these responsibilities when he returns in April while Dorothy and I are rambling around Bangkok and New Delhi. However, all roads lead to M.I.T. for our 50th reunion in June. . . . The **Wilfred M.** (Tommy) **Thomsons** will be at the 50th and accept Dale Spoor's challenge of last January. . . . We also hope to see **C. Randolph Myer** for his usual tennis match. Randy is president and general manager of Souhegan Wood Products, Inc. His special outside activities consist of the New Hampshire ski slopes and his garden—each at the appropriate season.

Irwin J. Smith is semi-retired from Surpass Chemical Co., of Albany, N.Y. He is still president but his son has taken most of the responsibility as vice president and general manager. Irwin will be with us if his health permits. . . . **Clift R. Richards** of Mt. Dora, Fla., still plays golf twice a week and attends various club meetings. He keeps about as busy as he cares to. . . . One of our most important class officers, **Everett W. Vilett,** is working hard as honorary secretary and member of the Educational Council. In 1970 Ev received the Outstanding Alumnus Award of the M.I.T. Club of Northern New Jersey. He was one of the founders of the club many years ago.

We send the sympathy of our Class to the family of architect **Earl T. Heitschmidt** who died of a heart attack last February in his San Marino home near Los Angeles. He was one of the designers of the Biltmore Hotel and specialized in large commercial projects including numerous banks, office buildings, colleges, hospitals and military installations. Earl was made a Fellow of the American Institute of Architects in 1949. He served on the California State Board of Architectural Examiners for 12 years and was chairman of the Advisory Committee for the U.S. Pavilion at the Brussels World Fair. He is survived by his wife Mabel, a daughter, Mrs. J. H. McCoy and a son Earl, Jr.

Our president **Parke Appel** has sent an encouraging message from San Marco Condominium, Venice, Fla. He will see that the 50th reunion is the best of all. He enclosed a March 12 clipping from Sarasota picturing **Ray C. Ellis,** who spoke about relationships between the U.S. and Russia after World War II. Ray was Deputy Director of the War Production Board during World War II after having spent 18 years with General Motors. In 1944 he made his first visit to Russia to set up an operative factory in Siberia. Since that time he has made nine more visits to Russia for government agencies. He was also vice president of the Raytheon Corp., until retirement in 1965. He now resides in Sarasota.

Among the changes of address are: Irving Ball, Brooklyn, N.Y.; Jose E. Espinosa, San Juan Rizal, P.I.; Ernest N. May, Wilmington, Del.; Edward A. Merrill, San Francisco, Calif.; Harold D. Stanley, Pompano Beach, Fla.; Frederick W. Wiegand, San Antonio, Tex.

In conclusion, re-read last month's notes on added contributions, blazers, reservations and bag-packing for our 50th ending with our tremendous final fling on Alumni Day, Monday June 12, 1972. With great anticipation we breathlessly await your arrival!—**Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 31 Montrose St., Newton, Mass. 02158

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We apparently missed the February issue, for which we apologize. We think the deadline notice went astray. The news this month is practically zero. We did hear from **John A. Frank,** A.I.A., who sent us one nostalgic reminiscence: "Not many years after leaving M.I.T. I was returning to New York where I had the good fortune to encounter Dean Burton. As some of us may know, the Dean spent some time with Admiral Perry in his early exploration of the Arctic. The skill and ingenuity of the Eskimos were exemplified by the Dean's tale of the broken gun that had been left behind by the explorers with the thought that it might be useful not as a firearm but merely as scrap metal. On their next year's trip they were surprised to find that an Eskimo had devised a substitute part, not of metal but of bone which restored the gun to usefulness." We agree with "Johnny" that although this event may sound tame today in this era of jet and space travel, it and others really take us aback. We remember when we initiated Dean Burton into the great "Shifter Society." He was a very human type of individual.

As of this reading, you should be aware of the dates for our 50th Reunion—May 31 through June 4, 1973. Also the location—the Marriott Motor Hotel on Route 128. We nicked you for ten bucks apiece for class dues needed to rejuvenate the treasury and help pay for the numerous mailings, etc. Again we remind you to send **Dave Davenport** your dossier for the class history (109 Bay Dr., Linkhorn Park, Virginia Beach, Va., 23451) which is rapidly nearing final editing. Marge and I are off on a jaunt to Curacao for a week's holiday. We promise not to miss on class notes for the next issue.—**Thomas E. Rounds,** Secretary-Treasurer, 4 Deer Hill Dr., Danbury, Conn. 06810

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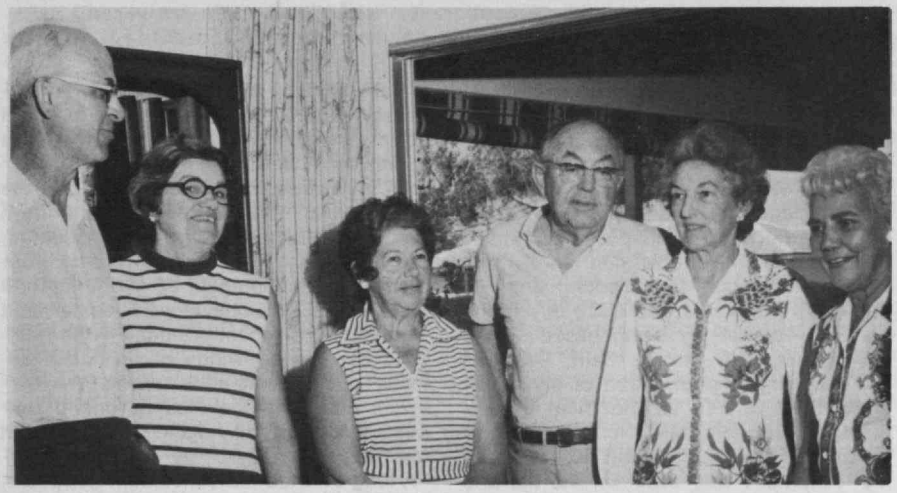
Your pen-pusher and wife were so enthralled by the weather and beauty of Arizona while relaxing there before returning to Brookline, that he missed the deadline. Being granted a few days reprieve by *Review* editors, the mail brought news, fortunately.

The biggest item consisted of details on the March 3 and 4 "First Florida Fiesta of 1924," co-hosted by the **Paul Cardinals** and **Pret Littlefields** at Moorings Bay, Naples, Fla. It was well written up in the *Naples Star* of March 9, complete with excellent three-column photos. The article, titled "48th Reunion is Funtime," reads, "Those who came to Naples for the fun of getting together with old friends included Frances and **Walter Bagby** of Bronxville, N.Y., who happened to be in Florida on Sanibel Island. The Conways came from Clearwater, Mary and **John Fitch** and **Boynton Fletcher** came from Vero Beach; Clare and **Gordon Harvey** were here from the Fort Lauderdale area, also the **Paul Millers.** Helen and **Dick Shea,** who winter in Venice, came down, as did Kitty and **Frank Manley** from Sarasota. Barbara and **Frank Shaw,** who live in Wellesley Hills, Mass., arranged a Florida vacation in order to make the reunion. Others were: (Ret.) Colonel **Henry** 'Hap' **Stern** and his wife Janet, from Palm Beach, and the **Joe Tryons** from Pompano



At a mini-reunion, held in Naples, Florida, some members of the Class of '24 are shown. Gathered around the piano at the top left are: (standing) Frank Shaw, Clare Harvey, John Fitch, Allora and Clinton Conway; (seated) Mary Fitch and Gordon Harvey. At bottom left: Walter and Frances Bagby, Janet Stern, Joe and Jackie Tryon and Helen Miller. While back in the kitchen (above) were Peg Littlefield, Paul and Lorene Cardinal and Pret Littlefield.

Beach. There was a dinner Friday evening at the Hilton Inn, and lunch on Saturday at the Cardinals' new home."

At the dinner, Paul read regrets from Luis Ferré, Al Roig, Nish Cornish, Rock Hereford, Jim Pierce, Nat Schooler, Ray Lehrer, Lloyd Porter (cancer of the bone), Dick Jackson (phlebitis in the leg), George Smith, Griff Crafts, Hunt Wardwell, Marshall Waterman, George Knight and Amanuensis. Pret Littlefield was dubbed Class Bard after the reading of his heart-rending six stanza, quatrain poem titled, "Moorings Bay," available on request from your scribe.

In December, **George Knight** and Edith were in New Orleans on a safari, via Volkswagen Campmobile, to Arizona, California, New Mexico and the M.I.T. Fiesta in Mexico City. George has abandoned sailing for the road and now is planning to winter in England, near Southampton, and summer in Hingham, Mass., as long as that seems practical. He had asked me for an opinion on a 50-Year Class historical document. My reply was negative: (a) where will we get the manpower and money? (b) Chick Kane's "Twenty-Five Year Report-Class of 1924" and his "M.I.T. in the Twenties" (1968) plus the Alumni Register are superb source material (c) only two classes, 1916 and 1923, have tried such a project and found it most difficult to complete.

Three of our Class, all members of the Institute of Electrical and Electronics Engineers, have recently again attained distinction. Dr. **Jorge H. Rodriguez** has been appointed vice president in charge of product development and production at SofTech, Inc., Waltham, Mass. He was awarded his master's in 1924 and his doctor's thesis in 1967 contributed the program graph model for parallel computations upon which much subsequent research has been based. He was the chief architect for the AED compiler and system-generating software technology developed under Air Force sponsorship at M.I.T.

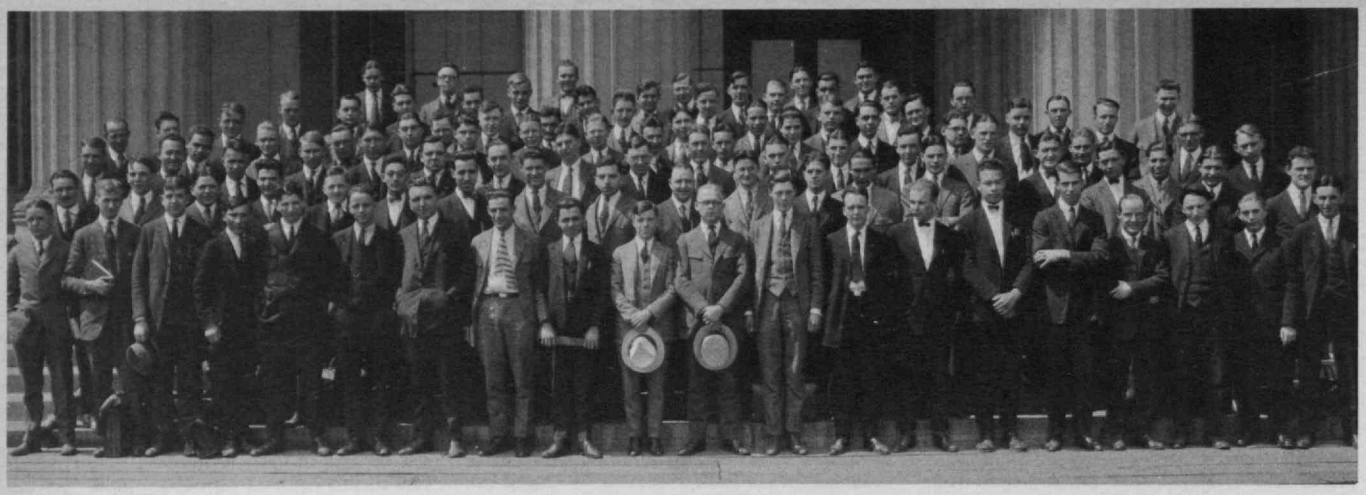
Frederick E. Terman, former Stanford Dean of Engineering, is Vice President and Provost Emeritus of Stanford University. During World War II, he organized and directed the Radio Research Laboratory at Harvard, which was the chief United States agency developing radar countermeasures. He was decorated by the British government and received the United States' highest civilian award, the Medal of Merit. Fred is an honorary member and held high offices in a number of scientific bodies. The author of numerous articles and books, his "Changing Needs for Ph.D.s" in the *I.E.E.E. Spectrum* of January 1972 presents the problem facing Ph.D.'s, after having been led by advisors and teachers to believe that investing time and money would assure them of exciting and attractive careers.

Herb Stewart, in January, entered distinguished company as one of the eight Vice Presidents of C.I.G.R.E. (Conference Internationale Grands Reseaux Electricite). They constitute the executive committee which meets quarterly in the United States. As reported in April, he will go to Paris in August for the Biennial Convention. Parlez-vous bien français, Herb?

Frank Shaw, Class Agent, is an honorable man! You did see that in February, he presented you a kingly letter, which should not be neglected. Ambitious? Yes Frank is sure ambitious especially when it comes to our Fiftieth Reunion Gift. . . . **Raymond P. (Pat) Schreiber** writes from the Japanese Gardens Mobile Home Estates in Clearwater, Fla., that the severe winters of Midland, Mich., catapulted him to the sun and orange juice area until April. He retired from Dow Chemical in 1966 and spent the last five years as manager of public relations, Greater Midland Area Chamber of Commerce. He found this an effective training in economics, a welcome change from chemical engineering practice.

It is always with regret that we report the loss of our classmates. The Class extends its sympathy to those near and dear, who have suffered bereavement.

Arthur Myron Kallet died February 25, 1972 in New Rochelle, N.Y., of viral pneumonia. Art came from Syracuse, N.Y., and received his degree in general engineering. He was active in R.O.T.C., *The Tech,* debating, speakers' club and the Electrical Engineering Society. After doing editorial work for New York Edison, American Standards Association and publicity for the New York Regional Plan Association, he founded Consumers Union in 1936, which he built into the leading consumer testing



Members of Course VI of the Class of '25 in the spring of 1923.

organization. In 1957, he co-founded *The Medical Letter,* which fortnightly, evaluates new drugs and therapeutics. Co-author in 1933 of *100,000,000 Guinea Pigs,* the book was on the best seller list for two years and sold 250,000 copies. He was also the author of *Counterfeit—Not Your Money, but What It Buys.*

The widow of **Karl E. Luger** has advised us that he died July 28, 1968 in Houston, Texas. He came from the University of Minnesota and received his master's in chemical engineering practice. Karl spent 20 years as a metallurgical engineer with large companies and then founded his own business in Houston.

A newspaper clipping indicates that **Richard H. Walker** passed away on February 3, 1972 in Roxbury, Mass. Dick spent two years with us and then went to law school. He was a lieutenant in World War I and saw action in France, being awarded the Silver Star and Purple Heart (Oak leaf cluster). A self-employed electrical contractor until 1930, he then spent most of his career in state and federal agencies, being on the War Manpower Commission, 1941-1945.—**Russell W. Ambach,** 135 Aspinwall Ave., Brookline, Mass. 02146

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As this is being written the Ides of March are approaching and after a relatively mild winter we are getting our annual allotment of snow dumped upon us in a few short weeks. This often happens to make New England weather more interesting.

John E. Yarmack of San Mateo, Calif., sends what he calls his "nostalgia" story: "I was born a few days after this century began in 1900, graduated in 1925 and retired in 1965. Upon retirement I did some traveling. First to the Orient on an American freighter, then on a Japanese ship to South America. The third trip was to the Mediterranean countries on an Italian freighter and on a Greek ship through the Aegean Islands to Istanbul, Ephesus and Izmir. The last trip was on a Norwegian freighter to the South Sea Islands. Several trips to Mexico and Hawaii and one to Alaska complete the list. Presently we are about to take off for East Africa (Ugana, Kenya and Tanzania). We will *see* not *shoot* the animals!

"After 40 years in our Industrial Jungles and after dealing with many people I will be in a fair position to make comparisons with the African jungles and their inhabitants. After working and living in several states and D.C., this is the eleventh year of my being based at 126 Elm Street, San Mateo, Calif. 94401. I am enclosing a photograph of my fellow students of Course VI (Electrical Department). There were 166 of us. It was easy for me to keep track of the number, with my 'Y' initial I was 165th on the list and next to the last. The picture was taken in the spring of 1923. We were Sophomores then." It seems to me that John could be very helpful about travel if you need advice.

I regret to report the passing of **Byron J. Connell** of 1104 Mokula Dr., Kailua, Hawaii on January 30, 1972.—**E. Willard Gardiner** (Will), Secretary, 53 Foster St., Cambridge, Mass. 02138

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When the post office delivers a letter from a classmate these days we open it with hesitation. A letter from Mrs. **Leland W. Cummings** tells of Lee's death in October. Lee retired four years ago after 35 years with Sunoco and he and his wife had continued to live in Wyncote, Pa. . . . In the next mail George Makaroff wrote that his former associate in motion picture engineering, and our classmate, **Emil Kolisch** died very recently in New York. . . . A letter from Pablo Brosens in Argentina tells of the passing of his father **René Brosens,** '26, in late November. René was a founder of the M.I.T. Club of Buenos Aires and had sent three sons to M.I.T.; two received S.M.'s and one a Ph.D. Ken Lord wrote about **Carleton Everett**'s death last summer in Houston, Texas. Now hang on to your hat.

The Alumni Office has sent along a sheaf of additional deaths and unpleasant as it is we must list them—we will do it alphabetically: **William C. Baker, Erwin W. Berry, Orrin Colby, Della V. Egan, Charles F. Kirsch, Samuel W. J. Welch, William Wraith Jr., Leon N. Zaitzevsky.** To the families of this long list of classmates we extend the sincere sympathy of the Class of '26.

It's still winter as we look out upon the sea here at Pigeon Cove but the days are much longer and we are counting the weeks to the bright day when our sailboat will once again be gliding around the course. We have had some wild weather here recently though—one easterly that carried winds of hurricane velocity and mountainous waves. We survived with only the loss of one of our post lanterns and eight hours without heat and electricity.

A long awaited announcement of special interest to our Class has just been made: The noted historian, Elting E. Morison, whose writings on the social, political, intellectual and industrial history of the U.S. have commanded wide attention for nearly a quarter of a century, will return to M.I.T. effective July 1 as the Elizabeth and **James Killian** 1926 Professor in the M.I.T. School of Humanities and Social Science. Announcement of the appointment of Professor Morison to be M.I.T.'s first Killian 1926 Professor on a permanent basis was made by M.I.T. President Jerome B. Wiesner. Professor Morison, who served on the M.I.T. faculty for 20 years, first in the Department of Humanities and later in the Sloan School of Management, has been Master of Timothy Dwight College, Professor of History, and Director of the Scholars of the House program at Yale University since 1967. At the time he left M.I.T., Dr. Morison was Sloan Fellows Professor at the Sloan School. As Killian 1926 Professor, Professor Morison's appointment will be in the M.I.T. School of Humanities and Social Science without specific departmental designation. "M.I.T. is honored to have a scholar of Professor Morison's distinction return to its faculty and it is particularly fitting that, in doing so, he should become our first occupant of a chair established in honor of one of America's leading science statesmen, Dr. James R. Killian, Jr.," President Wiesner said.

We will give you an additional report later but wanted to get the good news to you without delay. As we reminisce to the wild roar of the ocean beating on

the rocks below, a lone gull glides on the somewhat more than mild northeast wind, not for fun, but ever on the lookout for that bit of sustenance that will keep him going for another few hours and that brings us up to our Cheerio.—**George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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This is the last chance to urge those of you who have not yet made up your minds to join us at Bald Peak. Reservations can be made pretty much up to the last minute. If you haven't been to a recent reunion or maybe never been to a reunion, I can say from experience: "Try it; you'll like it."

Dick Cheney will retire June 1 as President of the Glass Container Manufacturers Institute after 35 years with the trade association. He will continue his work with G.C.M.I. as a consultant on a part-time basis. Most recently, Dick has had top responsibility for all environmental and pollution control programs, in addition to his other duties as the organization's first full-time president. . . . While more and more of us are retired or thinking of retiring, **Gus Lobo** has just formed Lobo-Kane, Inc., a sugar brokerage firm at 120 Wall St., New York. He will be President of the new organization. . . . **Paul Vaughan** has had a lung operation but is still enjoying his retirement. He writes: "I never could sing, anyway. I look forward to a good sailing summer with relatives and friends."

So much has been written of **Edward Stone** that it is difficult to add anything. The Christian Science Monitor recently ran an interview with him, called him "America's best-known architect," and referred to his American Embassy at New Delhi as "the building that Frank Lloyd Wright called the finest in the last 100 years." . . . There are two new warm country addresses: David Knox at 223 South Palmway, Lake Worth, Fla., and Parker Ward at 10406 Sierra Dawn Dr., Sun City, Ariz. Eugene Herzog is now at 220 Oakwood Ave., Dayton, Ohio.—**Joseph S. Harris,** Secretary, Box 654 Masons Island, Mystic, Conn. 06355

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Clippings from *The Progress* (Caldwell, N.J.) of February 3, 1972 give us in word and picture an excellent account of a testimonial dinner honoring **Roberta Lovely Halligan.** The event, on January 27, marked the occasion of Roberta's retirement as health officer of the Borough of Caldwell. Many officials and employees of the borough attended the dinner. Among the messages of congratulations were a personal letter from Governor Cahill and telegrams from Florence Dwyer, her representative in the U.S. House, and from her senators, Clifford Case and Harrison Williams. From Roberta we have a message assuring us: "Although I have retired as Health Officer in Caldwell I have accepted appointment to the Roseland Board of Health and have agreed to serve as part time health officer of our neighboring community of Essex Falls! This is just to keep up with developments."

Two brief notes were received via Alumni Fund envelope panels. **Gus Stachelhaus** says: "Retired in June, 1971 from Sylvania Electric of Mountain View, Calif., operations. Now enjoying golf, fraternal lodge work, church activities, and traveling in the U.S.A. by VW campmobile. We are visiting our three children, three grandchildren, and wife's family and friends across the nation." . . . From Lou and **Sam Weibel:** "To Jim, Walt, et al: Too bad!—we had to appropriate your share of Milwaukee Dew at Hollis, N.H., last fall to close the cottage and return to Cincinnati, but there'll be more come spring. Hurry up and get through with that snow!"

Jim Donovan continues to be in touch with classmates upon all sorts of occasions. During the stormy Washington's Birthday weekend he and Frannie were cancelled out of attending a wedding and stayed home alternately to shovel snow and to rest. Pam and **René Simard** telephoned that Sunday evening from the Boston airport where, with their two younger children, they were storm-delayed on the way home to Ottawa from the Bahamas. Jim joined them for dinner (sautéd lobster) and a quick trip around the outside of M.I.T. so the children could see where Dad went to school. On the previous day **Dave Olken** had paid Jim a visit on some business matters. Then Jim had a letter from **George Bernat** who reported that he and Ruth are in good health. George is a strong supporter of the Institute and wants to see it become "an elite institution with the highest standards in the country." Jim also had a very nice letter from **Frank McDermott** written from Portugal where he and Marjorie were on a leisurely automobile tour along the "sun coasts" of Portugal and Spain. Their trip to Europe was partly spurred by a wish to visit son Bob and his family near Marseilles, France where Bob is on assignment for Bechtel Corp. The McDermotts' daughter Pat, with her family, lives in Forest Knolls, Calif., a place that Frank describes as very lovely country. Frank retired from Lever Brothers Company in January 1971 and continues to live in Darien, Conn.

In January we received a letter from **John Houpis** in Corinth, Greece. John expressed his disappointment in not meeting with **Des Shipley** while Des was in Greece. It appears that John was at his citron farm when Des called at the house. John wrote that his wife "Kiki" had died unexpectedly of a brain hemorrhage on December 8, 1971. They had been very happily married for 22 years and her loss was deeply felt. At the time of writing John was thinking of moving back to the states to live with his married son George in New York. A second son, Basil, is a junior at Fairleigh-Dickinson University, Teaneck, N.J.

A more recent traveler to Greece was **Florence Jope** who went to visit son Ted while his ship was in port at Athens. They explored the city together and, in addition, Florence took a number of bus tours on her own. Earlier this year Florence received a friendly letter from **Ethel Bernhardt.** Ethel had just had a difficult bout of illness that may require her to give up living in the north and to remain in Florida. She hopes to be at the reunion and wishes everyone well. . . . In a telephone chat with **Dud Collier** we learned that he is now semi-retired like most of us. He and Mary were contemplating a trip to England soon to visit her family there. Their daughter Jill is now in her second year at Leslie College. Dud had been in recent communication with **Ed Walton** in Scarsboro, N.Y., and reported that Ed had had some illness and was planning a vacation in Florida. Upon return the Waltons were intending to build a home in Whitefield, N.H.—**Walter J. Smith,** Secretary, 209 Waverly St., Arlington, Mass. 02174

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I regret to announce the death of Captain **Carleton C. Champion** on October 20, 1971 in Beaufort, S.C. He was a graduate of U.S. Naval Academy and in 1927, he broke several altitude records achieving a height of 38,419 feet. He is survived by his widow Helen A., a son Carleton C., and a daughter Mrs. Susan Morgan.

George R. Long of Dayton, Ohio, had been hospitalized last November for a serious illness. His condition has improved since and he is home and able to get around. . . . **J. Wesley Walters** of St. Paul, Minn., writes, "Since retiring from the corporation of Engineers in December 1965, I have enjoyed doing part-time work as a consultant to several state and county agencies in Minnesota and to an engineering firm on special flood protection planning. Between jobs, my wife and I have gone south each year for part of the winter season. We also managed to visit Hawaii, Europe, Eastern and Western Canada and Alaska. . . . A brief note from **Jarvis M. Hazard** of Bellerose, N.Y., states that he has retired from business since January 1, 1971 but continues the study of electronics in radio and television. His hobby is gardening and growing certain trees, such as chestnut from the seeds.

Paul F. Nocka of Canton, Mass., writes that he has retired as of last June and is enjoying the freedom of "green pastures" and spending time enjoying music, skiing and gardening. . . . **Murry M. Brimberg** of Silver Spring, Md., writes that one of his daughters, Carol Schulman is now a resident in pediatrics at Cornell, New York Hospital and her husband is resident in Obstetrics-Gynecology at the same hospital. His other daughter, Judith Sherwood just received her Ph.D. in biology and her husband is associate professor at Harvard Medical School. Each daughter also has presented two grandchildren; each with excellent health records. . . . **N. Vaughn Ballou** of Dublin, N.H., has retired and is living quietly in the woods of New Hampshire. His hobbies are gardening, photography, feeding and photographing birds, skiing, golf and snowshoe hikes.

John D. McCaskey of St. Joseph, Mo.,

writes, "last December I completed my thesis for an M.A. in history at University of Missouri. Graduating with 3.90 average which, all my classmates will remember, was not my G.P.A. at M.I.T. But at age 64, without Jose Ferré, the Old Howard, Wellesley, Vassar, New York, Cape Cod etc., there are few diversions. Moreover, 'old squares' are motivated by the desire to prove something to the young ones. . . . After Christmas, we will be back to Zihuatanejo, Mexico, to swim, fish and relax. One of the few quiet places left in Mexico.

Dexter T. Osgood, of Malverne, N.Y., writes that he has retired from A. T. and T., after 42 years of service. He has been travelling some, but mostly enjoying his leisure having enough to do to pass the time. . . . **Jackson H. Emery** of Wolfeboro, N.H., writes, "We have lived in Wolfeboro since I retired from service with the City of Mount Vernon, N.Y., in 1961. For the past nine years, I have been the only staff member of the local Libby Museum of Natural History in Wolfeboro, catering both to adults and children. Numerous M.I.T. men have made their retirement home here so I see their grandchildren on rainy days. My wife Ginnie has been very busy as a sixth-grade teacher, but in the future, we will devote more time to having our grandchildren and their parents visiting us summers. I shall be most happy to give a special tour of the museum to any future M.I.T. students if their grandparents will stop by during July and August. We are open everyday, except Mondays during the summer."

E. Neal Wells, Pinellas, Fla., writes, "Retired at the end of 1970 from work I enjoyed at A. T. and T., but was extremely glad to get away from New York City. We spent February, March and April (1971) in Florida and watched construction of our home in a condominium development. The rest of the year we put our house in New Jersey in shape for sale and cleaned out most of a life-time of accumulations. We moved here in mid-December to spend a green Christmas. There are many friends in this area and we already have had several visitors from the North. We will be back North in June." . . . **John F. Dreyer,** Montgomery, Ohio, writes, "I am trying to gradually retire from my business (Chairman of the Board, Palocoat, Inc.) I still expect to be active but on my own terms, with plenty of time for pleasure travelling. If anyone is interested in liquid crystals, I would like to correspond. We will be in California and Mexico in January. I expect that a few of our classmates remained in their respective specialized fields. I turned out to be a researcher and founded a business on the side; rough but worthwhile endeavor."—**Karnig S. Dinjian,** Secretary, 32 Oldham Rd., Arlington, Mass. 02174

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Again this year Teddy and **Howie Gardner** came East for the T.A.P.P.I. meeting and your secretary had a very pleasant luncheon meeting with them. Howie is Professor of Pulp and Paper Technology and also Professor of Chemical Engineering at the College of Forest Resources, University of Washington. He teaches, does administrative, research and consulting work and is currently developing the only four-year curriculum in pulp and paper technology west of the Mississippi. He has been active in T.A.P.P.I. for many years and has now moved into the upper echelon of the organization. Last year he was made a Fellow and this year he was elected to a three-year term on the Board of Directors. Howie keeps in good physical shape by hiking and swimming and says he gets "a lot of pleasure just in living in the beautiful Northwest." The Gardners' daughters are both married and living on the West Coast, Ellen in Laguna Beach and Carol in Walnut Creek, Calif.

Dave Giller has his own business in Boston, David Giller and Assoc., which does structural engineering and design work. He says that while recently rummaging through the attic he found some old issues of *The Tech* that anyone can have for the asking. The Gillers' daughter went to the Boston Museum School and then to Tufts for a B.A. She is now doing administrative work at the Manhattan School of Music in New York. . . . **George Gassett** is the piping and valve specialist of Stone and Webster's Nuclear Division. His work involves developing standard specifications and reviewing and approving all specifications for piping and valves on current nuclear power plant projects handled by Stone and Webster. George is still very active musically. Last year he played the flute and piccolo in some 60 concerts given by the South Shore Concert Band and he also plays in the Casino-Legion Band of Brockton. He is also an amateur winemaker with a stock of about 200 bottles. The Gassetts' two daughters are both married. Gretchen does public relations work for North East Life Insurance Co., and Quinby recently presented the Gassetts with their first grandchild, Britta, born January 1 this year.

Ed Giroux retired several years ago from his teaching job at Newton South High School. He and his wife Mildred are both painters and divide their time between a winter home in Pompano Beach, Fla., and their farmhouse in West Baldwin, Me., where Mildred has an art gallery. The Giroux' son Gerald, who is in the Air Force, returned from Viet Nam last July and is now stationed at Otis A.F.B. on Cape Cod. . . . **Fred Garvin** is division engineer in charge of the engineering division of the Boston Public Works Department. His division does all the necessary design, plan work and contract documents for highway, sewer and water projects. The Garvins have four children: Richard, who is a major in the Army, now in Korea; Lawrence, who is a systems analyst with G.E.; Jean, who is a kindergarten teacher and Maureen, who is a student at University of Massachusetts. Fred and Ed Giroux both mentioned the fact that they see each other from time to time.

Alfred Ennis, a specialist in the design of weapons systems, has retired from the Applied Physics Laboratory in Silver Spring, Md. He played an important role in designing the T.A.L.O.S. guided missile. As a design engineer, he "devised systems of integrating radar, computer, launch systems, missile, ship and men aboard Navy ships. This was his role in installing the missile systems on the U.S.S. *Galveston,* U.S.S. *Chicago,* U.S.S. *Albany* and U.S.S. *Long Beach.*" . . . **Paul Richardson** writes that he and his wife Gertrude are enjoying their retirement in Hampton, N.H. They hope to make a trip this spring to visit daughter Susan in Detroit and daughter Carol in Saratoga, Calif. . . . **Willard Selden** has had "a varied experience, the longest of which was quality assurance engineering from 1951 to 1968 when the Springfield Armory was closed." He is now a civil engineer in charge of pavement design at Westover A.F.B. The Seldens have two daughters: Barbara, who lives in East Longmeadow and has four children, and Martha, who lives in Ludlow and has three children.

Changes of address: Brigadier General Herbert W. Ehrgott, 4818 Avondale Rd., Washington, D.C. 20018; John B. Osborne, 489 Fairmount Ave., Chatham, N.J. 07928; Philip J. Riley, Gov. Weare Apts., Seabrook, N.H. 03874; Dr. Morris N. Young, Computer Sciences S.A. Ltd., 51 Juta St., P.O. Box 31497 Braamfontein, Johannesburg, South Africa.—**Gordon K. Lister,** Secretary, 530 Fifth Ave., New York, N.Y. 10036

32

Ed Nealand held an organizational meeting of the Reunion Committee in February and all members have been at work on their assigned responsibilities since then. The plans are shaping up great and we expect to see many of you on June 2.

William Barker and his wife will take a trip to St. Thomas and St. Croix but he will be back for the reunion and hopes to see a lot of the old gang. . . . **Eugene B. McBride** has moved from Bucks County to the Jersey shore where he is semi-retired and dabbling in real estate as an associate with Lockey Realty, Ship Bottom, N.J. His new address is 203 West 58th St., Brant Beach, N.J. 08008. . . . **Arthur D. Jewell** is retired and living in Washington, D.C. He was formerly Assistant Principal of McKinley Technical High School. He claims his hobby is mathematical nomograms.

John W. Flatley retired from General Services Administration in 1970. He enjoys golf and traveling and has plenty of nieces and nephews to visit. His home is in Washington, D.C. . . . Colonel **Arthur LaCapria,** of Laurel, Md., will be heading back to Alaska where he hunts brown bear on the Alaska peninsula and walrus in the Bering Sea. . . . Dr. **William Liben** is still working hard as a research physicist at the Applied Physics Laboratory of Johns Hopkins University. He says he has not yet had time for retirement or hobbies. . . . **Donald Rice** is with the Coast and Geodetic Survey branch of the Commerce Department and enjoys sailing in Chesapeake Bay.

A letter from his widow from 102 Evans Dr., Syracuse, N.Y., informs us that **T. Stewart Varey** died suddenly of a coronary on October 16, 1971.—**Elwood W.**

W. O. Bachli, '33

Schafer, Class Secretary, M.I.T. Rm. 13-2145; **James Harper,** Assistant Secretary, 2700 So. Grant St., Arlington, Va.

33

Top billing this time to our President, **Jim Turner,** who sent me the annual statement of his company, Textron. Jim announces his forthcoming retirement, except for "taking on special projects as the occasion permits", Jim intends to devote time to the many things he has always wanted to do. . . . Dorothy and **John Logan,** now of Boca Raton, came to see us recently at just the right time, 4:30 p.m., when things become festive. John retired from Jersey Power and Light last year, where he was chief engineer in charge of engineering and operations; he was also an executive vice president with General Public Utilities. The Logans have three grown children, a daughter and two sons. The Logans enjoy their condominium apartment, overlooking the ocean with a marvelous view. We were glad to see the Logans and would like to have more of you drop in. . . . We have a card from **Len Julian,** now retired and living in Brookline, on the same street where I buy my flannel undershirts. Len and Doris have just returned from a long visit to his old army haunts: Germany, Spain, India, and Thailand. They plan to return to Europe soon to visit their youngest daughter who is at the Cordon Bleu school in London. She is a former assistant editor of *Grand Diplome Cooking Course.*

A fine note from **Charlie Bell** tells us that he has just been paroled from his third hospital visit, following treatment for paroxysmal ventricular periocarditis. Golly, that sounds ominous, I must look it up. Charlie was able to spend Christmas with his entire family, fifteen in all. He is now broke and "will accept Care packages." Charlie assures us that he is OK but must slow way down for a long time. He allows that business (all three of them) is still barely solvent, but he has designed and built an automatic machine for a textile company, controlled entirely by pneumatic logic. Is this guy pulling my leg? Charlie, we all wish you well, and please do take it easy. Your nice letter proves that the (my) job is not thankless. . . . After too many years, we have word from **Werner Bachli,** who is in, or on his way to, India, where G.E.'s affiliated company is Elpro International Ltd., of Poona, 120 miles southeast of Bombay. Werner will have charge of manufacturing fused magnesium oxide, used extensively in insulation for heating elements. India produces a large part of the world's supply of magnesium ore. Jeanette, his lovely wife, and daughter Heidi, will be with Werner who intends to retire after this India stint. We are grateful for your fine, long message, Werner. Best of luck! From old faithful Cal Mohr we have a chiding about my mixing up Otto Putnam with Red Smith. I am meek, for sure. . . . A short release has it that **Maxwell D. Millard,** Vice President of U.S. Steel, has been elected to the board of the Rockaway Corp., of same town, N.J. . . . **Athelstan Spilhaus,** Chairman of the Board, A.A.A.S., pops up again in the news. It appears that Ed Muskie has prodded the society into appointing a committee of five "to develop policies for safeguarding independent scientific inquiry, and to ensure responsible scientific conduct." . . . More fame for **Thomas K. Fitzpatrick,** retired architect, who has been appointed to a jury of five for the 12th annual Reynolds Aluminum Prize for architectural students. The award is $5000 prize for the best original architectural design in which the creative use of aluminum was an important contributing factor. . . . We have a most interesting bit concerning **Robert** (Bob) **Heggie** and his connection with International Executive Service Corps. Bob has returned from a stint in Korea where he had an assignment with Tong Yang Confectionery Co., Ltd., as a volunteer consultant in candy manufacturing. I.E.S.C. is an organization of retired executives who volunteer to share their managerial know-how with enterprises in the developing nations. Great stuff, Bob. We wish you might condense your I.E.S.C. story, and make it available to your classmates.

We have a few Alumni Fund capsules which are always a lifesaver to secretaries who are in need of copy. **Paul Petitmermet** is still in his real estate firm in New York City. Son, Robert is now married after completing work for his Master of Fine Arts degree. Daughter, Jane, is also working on her master's. Paul says "they are getting ahead of me." . . . **J. Dyer Potter** appears to be reaching his objective of full retirement. He predicted this long since, and, when the paper work is finished, connected with the big bridge at New London, he and Petey will fly to Spain and Portugal. Dyer is completing 38 long years with the Connecticut State Highway Department. Keep writing, Dyer, and our thanks. . . . Lo, another old friend has retired: **Fred Walker** spent 32 years with the Bureau of Reclamation, U.S. Army Corps of Engineers, working on the construction of earth dams; he is doing some consulting work and enjoying his grandchildren—a worthy project, Fred. . . . **Rafford Faulkner** retired in January, 1972, from his position as the Director of Raw Materials, Atomic Energy Commission, after 20 years in the uranium end of this project. He was recently a delegate to the International Conference on Peaceful uses of Atomic Energy, at Geneva, where he was one of the principal speakers. He and his lovely intend to spend several weeks vacationing in Spain and Portugal.

We have a few address changes to report: Clarence W. Farr, AA; Morris Guralnick, NA; William B. Klee, ML; Maxwell Millard, EE; Eugene Nedbor, CE. These are all available to the faithful, under the usual conditions.

Alumni Records form #8900 informs us that my, and your, long-time friend, **John D. Howell** passed away in July, 1970. We have no information on John's surviving family, and would appreciate any information regarding whom we might write our condolences. We all regret his passing.

That's it for May, folks, and, Leona and I expect to see y'all at the 40th.—**Warren J. Henderson,** Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

34

This month my news has mostly been gleaned from Alumni Fund notes. The interesting thing is that of the six, three tell about retirements. It should not be surprising at this stage in our lives, but getting this many at once sort of drives it home.

George Westefeld writes "I am retiring February 1, 1972 from Anaconda American Brass Co., Central Engineering Department after 37 years of service. I will continue to live in Cheshire, Conn." . . . From **Ed Asch,** "I guess I never did check in officially with you that I had checked-out of the corporation existence. I left Sperry Rand Corp., after 29 years in its Vickers Division, my last job being operations manager of the International Division. Prior to that I had been European Marketing Manager, living in Lausanne, Switzerland and before that, District Manager in Houston, Texas. Thus, we elected to return to Houston where I am not 'working' but am busier than ever." One of my major recollections about Ed is that by either our first or second reunion, his hair had turned completely white. I can recall distinctly the comments that it brought forth.

Finally, it seems that **Ernie Massa** has turned coward and has run away from the New England winters. Maybe it's just that he has gotten old and feeble. He says, "I sold my home in Cohasset, Mass., and retired to Florida where I hope to make up all the golf I have been missing." His new address is Apt. 1626, 405 N. Ocean Blvd., Pompano Beach, Fla. . . . Now for the hardier souls who are still working, **Frank Moore** is still hard at the railroad business, to wit: "Just returned from vacation in South Africa, visiting the South African railways. Am project manager of the engineering of the electrification Reaching Railroad from Hatboro to Warminister. I am also working on the appraisal of the Penn Central." That last item alone

Herbert Schwarz, '34

should provide practically a lifetime of work for someone a good deal younger than we are.

Albert Schulerud writes, "Went to Sao Paulo, Brazil in February 1971 to successfully prove the practicability of a new process development arising from my recent appointment as a Research Associate (with Colgate Palmolive Research Labs, I think-R.M.F.) Have continued my singing as bass soloist in a regular church job and in the Oratorio Society of New Jersey." . . . Finally, from **Harry Heiligenthal,** "As Vice President of Dayco Corp., and in the 'twilight of life'—getting ready to enjoy some hobbies and 'girls'." It sounds almost as though one of those two projects is redundant.

I have word of two promotions, **Herbert R. Schwarz** has been named assistant merchandiser of Woven Filtration Products for West Point Pepperell Industrial Fabrics Division. He has been with the company in the New York area for 36 years. Herb and his wife Emmy Lu, their two daughters and a son live in Port Washington, N.Y. . . . At the Simplex Wire and Cable Co., **Loren H. Hutchins, Jr.,** has been named Technical Director. Loren, who lives in Portsmouth, N.H., joined Simplex in 1939 and has been continuously involved in the design, development, test and application of submarine cables and systems.

I am sure that many of you realize that a good deal of information about the Class comes in news released from the companies where our members are working. My final item comes from one of the most unusual of these releases I have seen. It was issued by the International Executive Service Corps., a non-profit corporation for retired executives to share their know-how with businesses in developing nations. From it I learned that **George Merryweather** and his wife had just returned from a three-month stay in Taipei, Taiwan. George was formerly general manger of the Economy Machine Tool Corp., and is a past president of the American Machine Tool Distributors Association. His assignment was with the Industrial Development Bureau, advising on industrial machinery marketing. It would be interesting to hear from him as to how fruitful he feels help of this nature can be.—**R. M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631; **G. C. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

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The following notes were received through the Alumni Fund Office: From Tel Aviv, **Michael G. Kelakos** wrote "My tour here as Scientific Attache of the American Embassy has been extended until 1973 at which time I shall be retiring from the U.S. Foreign Service. Our son (age 14) and daughter (13) are both attending the American International School in Israel and have managed to add a working knowledge of Hebrew to their English, French and Italian." . . . **Lew Simon** wrote from Oxnard, Calif., "Am embroiled in fighting promoters and realtors on ecological front—mostly an unneeded jet port, and trying to sell a passive restraint safer, simpler and less costly than the air bag for cars." . . . From York, S.C., **James E. Castle** wrote "Retired, but doing enough consulting work in the mineral industries to arrest rust." . . . A note mailed from Toronto reads: "On October 29, 1971 I was invested with the Medal of Service of the Order of Canada by the Governor-General of Canada, Government House Ottawa, who is Chancellor of the Order. The service for Canada cited was in aeronautical engineering"—signed, Elsie Gregory Mac—I. I have been unsuccessful in finding her in any of the directories or computer print-outs. If anyone can help with identification, please write.

I am sorry to have to report the death on January 15, 1972 of **Hermann Laudani** who lived in Reading, Mass., with his wife and son John. He was general superintendent of the Mystic Valley Gas Co., at the time of his death. He was with us in Course X-B and received his degree in 1935. Hermann was a past president of the Reading Lions Club and a member of the Masons and the Italian-American Civic Association. To Nella and son John I send the sincere sympathy of all his classmates.

I received a very nice letter and enclosure from Stocky and took them to my office so I could reply. Now I am at home recuperating from that heart attack and Stocky's letter is not readily available, but I shall include it in next month's notes. Another quickie: **James S. Craig,** Course IV, is in charge of development of the Lewis Wharf owned by the Boston Waterfront Development Corp., which recently received authorization to proceed from the B.R.A. I expect to be back in the office and out on the golf course by the time you read this.—**Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

With President **Tony Hittl**'s support your Secretary is inviting all of you who can, to join her in West Hartland, Conn., on Saturday, June 24, for a '36 picnic. The mountain laurel should be in bloom and the water just right for swimming. If there's any wind there should be sailing. You will be welcome anytime from 10 a.m. until dark. I live on a small lake about eight miles northeast of Winsted, 25 miles due west from Bradley Field. We figure on a little over two hours from Route 128 or from the Tappan Zee Bridge. You'll hear more from me later—do save the date.

Paul Robbins has been in the news testifying before Senate hearings as a spokesman for the National Society of Professional Engineers of which he is executive director. His concern is for the shift in emphasis toward civilian-related activities for engineers and their need "to shift gears."

Earlier I reported the death of **Harry Tichnor.** He died in June, 1969. More recently the Class has lost two graduate members from its rolls: **Russell Bandomer** of Cincinnati on October 29, 1971 and **Sherman Shull** of North Caldwell, N.J., on February 1, 1972. Our sympathy goes to their respective families.

By a circuitous route I learned that **Jim Allen**'s daughter is working for her Ph.D. in Biology at Berkeley. The Allens live in Washington, Penn.—**Alice H. Kimball,** Secretary, Apt. 8-6C, 100 Memorial Dr., Cambridge, Mass. 02142 or P.O. Box 31, West Hartland, Conn. 06091

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All of our class has received mail about our 35th reunion at Chatham Bars Inn on Cape Cod, June 2 through 5, 1972. It is shaping up to a grand time and if you haven't sent in your registration form, there is still time to contact **Joe Heal,** 39 Tower Rd., Hingham, Mass. 02043, with a firm *yes* and *dollars*. Don't forget to fill out your questionnaire and send it to **Len Seder,** 267 Hawthorne St., Malden, Mass. 02148. Time has run out and prompt action is necessary. I hope to see you and your wife at the reunion. . . . Heard from **Dick Young,** who is now living in London, England. He and Marge are planning to be at our reunion and looking forward to revisiting with old friends.

Ray McFee for the past four years has been with McDonnell Douglas Corp., in Huntington Beach, Calif. He was first associate director of the Advanced Research Laboratory and then Senior Staff Engineer in Electro-Optics for the M.D. Astonautecs Co.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 01255; **Curtiss Powell,** Assistant Secretary, Rm. 5-325, M.I.T., Cambridge Mass. 02142; **Jerome Salny,** Assistant Secretary, Egbert Hill, Morristown, N.J.

38

The big news this month is that Prexy **Bob Johnson** has signed up **Paul Black** to serve as the chairman of our 35th reunion in 1973. I am sure that Paul will welcome any suggestions you may have, and particularly, your services on one of the many sub-committees which are essential to a successful reunion. Paul can be contacted at Sylvania Electrical Products, Inc., 40 Sylvan Road, Waltham, Mass. 02154.

Benjamin Siegel has been named president-elect of the Electron Microscopy Society of America. Ben is a professor at Cornell, where he is currently working on development of a high resolution electron microscope to extend the capabilities of the electron microscope in the field of molecular biology.

Another first for 1938: One of our classmates rated a full-page in the *New York Times,* Barron's, and the *Wall Street Journal,* as was pointed out to me by both Burt Grosselfinger and Don Severance. **Yale Brozen** had delivered a speech on "Advertising, the Consumer and Inflation", which was printed up in a one-page summary. Yale is Professor of Business Economics at the Graduate School of Business, University of Chicago. Burt, who is also a Course X renegade, reminded me that Yale was in Course X with the remark "Has any M.I.T. man commanded a full-page of the *Times* before?—and '38 and Course X?"

One last thought: are you signed up for Homecoming? See you there—**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney and Co., 140 Broadway, N.Y. 10005

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Irving Peskoe wrote that he has joined the M.I.T. Educational Council, and at the time of writing he was facing with some trepidation his first interview, with the son of a long-time friend. Irving's youngest daughter is now a freshman at Georgetown University. . . . **Roger W. Swartz** is now on the board of directors and an administrative assistant with Horner Elevator Company, College Park, Md. . . . **Millard M. Brenner** wrote that he is changing his career from electrical to civil engineering, and that he will send us further details later. . . . **Aaron White** sent along a clipping about **Paul N. Stanton,** and then Paul himself wrote with further details: He has left Colt Industries and is now vice chairman of the board of the C. Pappas Co. and Pappas Enterprises, and of the Board of Governors. He divides his time between offices in Boston and Athens, Greece.

Professor John Wilbur, recently retired from M.I.T.'s Civil Engineering Department, forwarded a nice letter from **J. W.** (Bill) **Pocock,** senior vice president of Booz-Allen and Hamilton, Inc., Washington, D.C. Bill is getting back into civil engineering activities, including directing a planning study for the Directorate General of Highways in Vietnam. . . . Board chairman **William S. Brewster** of U.S.M. Corp., served as campaign chairman for the Massachusetts Bay United Fund. . . . **Robert C. Casselman,** management consultant, served on the Seminar Committee for "The Future Character of the Urban Fringe," held at the Institute April 29 and 30. Bob has left his work with state government, after four years of working for reform. . . . After 34 years with General Electric, **Richard E. Christie** has joined Apache Corp., of Minneapolis to head up a new industrial products and services group. . . . **Alexander Squire,** a veteran Westinghouse Electric Corp., nuclear specialist, has been named president of WADCO, a Westinghouse subsidiary which manages the Hanford Engineering Development Laboratory in Richland, Wash., for the A.E.C. . . . It is most welcome when a 39er wife writes, as did Mary (Mrs. **Martin Lindenberg**) recently. Among other M.I.T. activities, she and Martin attended the 1971 New England Executives Conference at M.I.T. in November. Mary frequently contributes solutions to problems appearing in Allan Gottlieb's Puzzle Corner. She was a math major at Hunter College, and "fondly recalls when Martin and I used to discuss calculus problems when we were dating."

Herbert A. Finke died on November 3, 1971, after a long illness. He had been employed by R.C.A., I.T.T., and P.R.D. Electronics, before becoming vice president of Varian Associates and finally president of the national company. Afflicted by Parkinson's disease, he had retired in 1965. . . . Here is notification also of the death of **John F. Aldridge, Jr.,** on May 23, 1971. No further details available, although he was listed on the 1967 Alumni Register as Vice President, McDonnell Aircraft Corp.—**Oswald Stewart,** Secretary, 3395 Green Meadow Circle, Bethlehem, Pa. 18017

40

For one of the few times in the last 22 years, there was no '40 column in the February *Review*; no news was received from classmates. No comments received regarding the omitted column, so apparently it wasn't missed. The best I could do was furnish a little news to the secretary of the class of '26. Belatedly, there is the always entertaining letter from Virginia and **Ray Keyes** and family: "Our greetings to you from the banks of the picturesque Yakima River! This year we found from sad experience with baby calf-raising that success requires much motherly care and some veterinary know-how. Dumb as she is, mother cow can instinctively do the superior job of calf-raising. There is one exception, our Jersey shorthorn cow, Gertie, who had twins. Her bull calf stayed with her, but her heifer lagged behind and was lost for three days. We found her healthy among our neighbor's herd. He did note that some of his cows were unexpectedly dry. The little heifer did so marvellously as an orphan it was a battle to get her back on Gertie. Getting Gertie to reaccept her own offspring was over half of that struggle.

"Greg's present interest is karate with a ritual of kicking, chopping and grunting. Kristin does kicking too but without chops and grunts. Hers is called ballet and is much more rhythmical and graceful. She is in the eighth grade now. Ray won a trophy of a man holding a bull on his shoulder. At first you might guess it to be a funny award for cattle-raising. No—it is an award for being funny. Speaking on modern hirsute and unisex styles and women's lib he got enough laughs (at least from the men) at a Toastmaster competition to win the prize for humor (hardly a Buchwald). Actually the Yakima River is not picturesque when viewed close-up. It is filthy. Its water, while born crystal clear in the eastern slopes of the Cascade Mountains, passes through communities comprising about 300,000 people before reaching our banks as the most polluted water in Washington State. We are hoping that Santa will bring us a clean Yakima River some Xmas soon."

John Evans has been elected president of the Toledo, Ohio chapter, American Institute of Architects for 1972.

With regret I must report the death of **James H. Campbell.** He died at the age of 61 of a heart attack. He was in Course XV. At the time of his death, Jim was president of Consumers Power Co., builder of the first nuclear power plant in Michigan. The $27 million Big Rock Point plant at Charlevoix, Mich., was built in conjunction with General Electric and dedicated in 1963. Prior to attending Tech in 1939 on an Alfred P. Sloan fellowship for graduate study, Jim graduated from Purdue in 1933 and worked for Consumers Power. In World War II he took part in the Italian campaign with the Fifth Army, rising to lieutenant colonel. After war service, Jim rejoined Consumers Power and became division manager in Grand Rapids in 1947. He was elected a vice president of the company in 1950, a director in 1952 and president in 1960. He was a member of the Edison Electric Institute's policy committee on atomic power, a vice president and trustee of the Power Reactor Development Co., owner and operator of the Enrico Fermi nuclear reactor near Monroe, Mich., and a vice president of the Atomic Industrial Forum. Survivors include his widow, Jane Hewett Campbell, and three sons.

Some of you may have noted the report in the February *Review* of the death of Oscar Hedlund, beloved by many of us as track and cross-country coach and friend, both during our years at Tech and after. Your secretary has given a donation to Tech to be spent on track and cross-country (no athletic scholarships please). Possibly others may wish to donate to Tech in Oscar's memory. Write to—**Al Guttag,** Secretary, Cushman, Darby and Cushman, 1801 K St., Washington, D.C. 20006

41

Several items of interest this month for former classmates of 1941, with news of accomplishments arriving from all areas of the country.

A news release from Dallas, Texas, dated February 21, announced **Ralph Landau,** President of Halcon International, Inc., New York, has been honored with the Third Petroleum and Petrochemical Division Award at the 71st National Meeting of the American Institute of Chemical Engineers. Congratulations, Ralph.

A note from **George S. Cherniak** indicates he is now vice president of T.R.W. Industrial Operations in California, living at 516 San Vicente Blvd., Santa Monica.

In the day of increasing problems in the drug abuse situation in the country, it is encouraging to note the Carnegie Corporation, the Commonwealth Fund, Ford Foundation and the Henry J. Kaiser Foundation, are funding a major national agency known as the Drug Abuse Council. One of the fifteen members appointed to this august group is our own **Albert H. Bowker,** Chancellor of the University of California at Berkeley.

David Shapiro, after twenty years with Sperry Rand Corp., announces a new endeavor with North American Planning Corp., an investment and underwriting firm located at 230 Park Ave., N.Y. Before leaving Sperry Rand, Dave managed the development of the Multiphasic Heath Testing System, information on which was published in the *Sperry Engineering Review*. Good luck in the new activities, Dave.

Another news release from the United States Air Force, Scott A.F.B., Ill., announces the appointment of **Robert D. Fletcher,** A.W.S. Chief Scientist, to a post with the international American Meteorological Society, composed of eminent weather scientists from several governmental, academic, industrial and military weather organizations. . . . **Henry Avery** is running for Regional Vice President of the Alumni National Nominating Committee.

Not a bad month for 1941. Please keep us advised of your activities, since your classmates are interested. . . . The paper used for preparation of news for the *Tech Review* is a fine healthy green color, which makes it rather appropriate this "deadline" day, since it is March 17. This will reach you after the fact—but Happy St. Patrick's Day in any event.—**Michael Driscoll,** Secretary, P.O. Box 1044, Nantucket, Mass. 02554

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It does appear that spring will arrive. Tomorrow, March 20, is officially spring but I was beginning to have my misgivings that there had been a misprint on the calendar. I suppose we shouldn't complain about the past winter. Our two skiers, Paul and Mike, had good weather once the winter finally arrived, skiing near Cleveland, in Michigan, and the western parts of New York and Pennsylvania. Our three eldest children attend O.S.U. in Columbus. They are now in Florida enjoying the sun and beach as a reward for their fine achievements this school year. Imagine, high school boys go skiing, and college students go to Florida, but poor mom and pop never seem to be able to go anywhere. The mail lately has been extremely sparse. As a result we have been gathering most of our material from the 25th reunion book. Please, all of you who do not have a biography in this book, please write as everyone will enjoy hearing from you.

After graduation from M.I.T., **James T. Todd** took a job with Procter and Gamble in the industrial engineering department in Baltimore. For the next ten years of his career Jim held various line and staff jobs before being transferred to Cincinnati as plant industrial engineer. In 1960 Jim left Procter and Gamble to go with the consulting firm of Robert Heller and Associates in Cleveland. Jim joined Mobil Oil in New York two years later where he was in charge of the industrial engineering program of Mobil's U.S. refineries. After eight years at Mobil, Jim joined the Union Carbide management services department as a managing consultant. The Todds have three children, James 22, Michael 19 and Tracey Ann 10, and now reside in Westport, Conn.

Peter S. Wright joined Grumman Aircraft after graduation as applied loads engineer. He enjoyed the five years on Long Island and began his family that was to grow to five boys and one girl. Peter left Grumman to join Vertol as dynamics engineer and the family moved to Philadelphia. In 1955 Pete joined the General Electric Missiles and Space Vehicles Department as nose cone design engineer. In June of 1959 he joined Teleflex as project engineer where he has been since, rising to senior staff engineer. Pete's hobbies are developing his own business and improvement to his home in Wayne, Pa. . . . Also from the reunion book we are pleased to report on **Charles Wellard.** Charles received his M.S. from Carnegie Tech in 1947. He is now president of American Components, Inc. of Conshohocken, Pa., but has previously traveled extensively for the company in Europe and the Far East. The company has factories in England, Germany and Japan, and plan to add facilities in other parts of the world. The Wellard's oldest daughter will graduate from North Carolina in June while a second daughter is at Linden Hall School for girls, and their son, Chuckie, is in the fourth grade in Pennsylvania.

Jorge M. Sanchez Aguilar obtained an M.S. degree in Naval Architecture and Marine Engineering at the University of Michigan following graduation from M.I.T. Jorge managed a boat yard in Alvaroda and built shrimp trawlers and navy patrol boats. He joined Westinghouse as chief industrial engineer and was with them for six years before joining Norris and Elliot as manager of industrial engineering for Cipsa-Monsanto plastic products plant. Jorge also organized and established graduate courses in systems for electrical and mechanical engineering leading to M.S. at E.S.I.M.E. National Polytechnic Institute of Mexico. Jorge is now the manager of labor relations for Goodyear Oxo, S.A. Jorge and his wife, Liba, and ten children live in Mexico City. I am sure that the ten children keep Jorge busy, but he still has some time for tennis, swimming and hiking as well as his university work.

Two short notes from the replies that accompany donations to M.I.T. **Edwin F. Potter, Jr.,** has joined the Norden Division Aircraft in Norwalk, Conn., and will soon be moving there from Long Island. He will be working in the advanced products department. . . . **W. H. Turner** is engineering director, equipment and buildings, for A. T. and T. Some facets of his job are to help A. T. and T., eliminate pollution, hire minorities in building construction and locate more facilities in high unemployment areas while paying higher wages, raising dividends to stockholders and minimizing telephone rates. Gosh, those problems don't seem so difficult. Until next time—**Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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This month's report is being written while enroute on T.W.A. from Boston to London. I am traveling to Wales where my company's Fram Filters, Ltd., division is located. T.W.A. had a bomb explode on one of their 707's earlier this week. Presumably, if you get to read this, a bomb did not explode on tonight's flight.

On February 23 **Ken Brock** had Jeff Ingram arrange for **Charlie Adams, Bob Bliss, Herb Marcus,** Ken, and myself to conduct a class of '48 telethon from the Alumni Fund office. After supplying a catered dinner consisting of smoked meats on whole native grains (baloney sandwiches), and sliced whole potato in hydrated vegetable oil dressing (potato salad), Jeff explained that we were to call individual members of the Class of '48 and ask them to increase (at least quadruple) their gift to M.I.T. Stacks of cards with names and telephone numbers were provided; as were telephones. After 140 attempts, the five of us spoke to 95 classmates. We obtained 79 pledges of which 40 were increased over last year. Approximately $4,000 was pledged by these 79 members of the Class of '48.

I called **Harold Hollister** in Ohio to ask for an increased pledge. Like many other members of the Class of '48, Harold only spent one year with our Class since he started as a member of the class of '44. Harold is farming full-time; growing corn and raising hogs and pheasants. . . . When I spoke to Karl Justin he asked for more information about Joe Yance. A few days later Karl wrote me the following for the notes: "**Dick Harris** and **Karl** (Skip) **Justin** say that judging by the marriage announcement in the '48 class notes in January, **Joe Yance** is obviously alive and well—but where is he hiding?" Would he please send his address to me, Marty Billett, so I can pass it on to Dick and Karl because they need his measurements to complete their Profile Analysis of the Class of '48 in time for the 25th reunion.

Bob Crane was the speaker at the March meeting of the M.I.T. Club of Long Island. Bob discussed the ethical dilemma of the medical profession caused by the limited availability of life-saving equipment and transplant donors. . . . **John Weil** recently published an article "An Introduction to Massive Stores." John suggests stores with capacities near 10^{12} bits are now becoming practical using technologies which are capable of achieving 10^8 bits/inch^2. One result of the development of massive stores will be that existing information retrieval systems will need careful rethinking if it becomes more economical to store and recall information from massive store systems than from the conventional filing cabinets, shelves and libraries. John is with Honeywell in Waltham, Mass., as director of advanced systems and technology. . . . **Otto K. Wetzel, Jr.,** is still with Purvin and Gertz, Inc., Consulting Engineers. They now have offices in Houston, London, and Tokyo, in addition to the head office in Dallas. They consult on the economic utilization of oil and gas. . . . **Ted Yoos, Jr.,** has been nominated as a candidate for an officer of A.S.M.E.'s Boston section. Ted is with C.L.M. Systems Inc., Consulting Engineers in Transportation and Computer Systems.

During the recent telethon, I started a "friends" list. Using the list of friends, I plan to help the exchange of addresses between classmates who would like to know if their friends are planning to attend the 25th reunion in June, 1973. **Jay Jennis** asked for **Sheldon Green**'s address. **John LaMarsh** wanted to exchange his reunion plans with **Dick Shotlin. Bill Lockwood** wanted addresses for Martin Judge, '47, and Chuck Loucks, '47, **George Clifford** asked about **Norman Everett**'s plans. **Norman Hobbs** wanted **Dan Fink**'s address. **Harry Kopp** is interested in attending, but had no specific classmates to check with.

The plane is in its final approach to Heathrow Airport. It is 4 a.m. Boston time and 9 a.m. London time. I'm looking forward to going to bed at the Excelsior Hotel, near Heathrow.—**S. Martin Billett,** 16 Greenwood Ave., Barrington R.I. 02806

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I have just returned from five weeks in tropical climes to find that, for once, I missed the worst of winter. During the worst two weeks, I was alone in Brazil on business. My wife, Sonya, has a somewhat different view than mine on this whole situation. Hers is mostly unprintable. When you read this issue, time and the arrival of spring should have restored a degree of tranquility to all concerned. From the Alumni Fund envelopes, two notes: **William Glodt** reports that he has been the Fund Chairman for the Rockville, Md., area from '69 through at least '72. . . . **Jim Marshall** brings us up-to-date with "I have been teaching Engineering at the Villanova University for some years, having settled down in the nearby town of Swarthmore, Pa. Music has claimed much of my spare time as an avocation. I am a cellist, with amateur string quartets which meet regularly and I have done some graduate study in music theory and composition at the University in Pennsylvania. Have enjoyed camping and travelling with wife, Maud, and children, Pam and David, including Adirondack hiking and a recent trip to Europe."

At the 138th Meeting of the A.A.A.S. in December, **Paul Ostergaard** presented a paper, "Can Industrial Plants be Adequately Quieted?" to a seminar on environmental noise and its control, another form of pollution now receiving a good deal of attention in industry under the Occupational and Safety Act administered by the Department of Labor. Another form of pollution of increasing concern to one of our classmates is solid waste disposal. . . . **Bruce Campbell,** Commissioner of the Massachusetts Department of Public Works, specifies solid waste disposal, along with highways and waterways, as the major programs for the D.P.W. in a feature interview in the Lynn item on February 16, 1972. Judging from the article, Bruce seems to be bearing up well under his very sensitive position, heading a mammoth department where every project seems guaranteed to generate increasing dissension among groups who disagree on relative importance of benefits and costs.

From M.I.T., an announcement that Dr. **Eugene B. Skolnikoff** has been appointed Director of M.I.T.'s Interdepartmental Center for International Studies. He remains professor and head of the department of political science and will divide his time between the department and the C.I.S. Previously, the C.I.S. has been a part of the M.I.T. School of Humanities and Social Science. However, effective with Professor Skolnikoff's appointment, the Center will become Institute-wide in character and will seek to draw research participation from all M.I.T.'s academic departments in all five schools, encouraging still further multi-disciplinary approaches to international social and political problems: such as, arms control and limitation, industrial and economic growth in emerging nations, techniques in the avoidance of armed conflicts, and problems of developed nations.

Two 1949 graduates were appointed as Directors of the Lincoln Laboratory of M.I.T. **Walter E. Morrow,** B.S., '49 and M.S., '51 in Electrical Engineering, is Associate Director and **Daniel E. Dustin,** M.S., '49 in Business and Engineering Administration, is Assistant Director Congratulations all three on your new positions of responsibility in the M.I.T. Community.

That's it for this month. Best wishes to all.—**Frank T. Hulswit,** Secretary, 77 Temple Rd., Concord, Mass. 01742

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The board of directors of the Institute of Electrical and Electronic Engineers has conferred the grade of Fellow on **Kenneth H. Olsen** of Digital Equipment Corp., for contributions to digital computer design, manufacturing, and marketing. . . . After two years in Holland and five years in England, **Roy W. Jenkins** has been living in Singapore for one and one-half years. As Far East area manager for the Foreign Marine Division of Brown and Root, Inc. of Houston, Texas, Roy is spending lots of time flying hither and yon. He would be interested in hearing from 1950 graduates of Course XVIII and Course I.

Charles J. Lucy has been named manager of business development at Corning Glass Works. Charles joined Corning Glass Works in 1952 as a research engineer, subsequently serving as a production supervisor and a sales development engineer for electronic and nucleonic products. In 1958 he was appointed to the electronic components staff as a supervisor of applications engineering. He was named supervisor of product and applications engineering in 1959, manager of market development-special products in 1961, and manager of the Electronic Devices Department in 1962. Since 1964 he has been manager of market development for the television products division.

D. T. Ross of SofTech, Inc., has a paper on Automated Engineering Design used for graphics published in the Honeywell Computer Journal. This paper is of particular interest because the Automated Engineering Design system has been adopted for the Honeywell 516 Computer.

—**John T. McKenna, Jr.,** Secretary, 2 Francis Kelly Rd., Bedford, Mass. 01730

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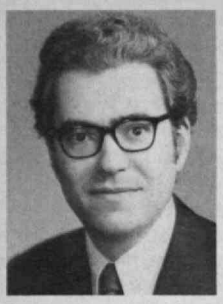
Andy Wessel writes that he lives on a small farm 20 miles west of Oslo, Norway, with his wife Liten and five children, two boys and three girls, aged 13 to 3. The farm is located on top of a hill, 1000 feet up, so the view towards east, south and west covers a radius of about 30 miles. The kids are very good skiers; the oldest Andy, junior, was just picked for the Norwegian Nationals. Andy says his job is fine. His firm, WESWITCO, started with his uncle in 1957, now has 100 employees and $4 million sales. . . . **Newell J. Trask** is now staff geologist for astrogeology in the Office of Environmental Geology, Washington, D.C. Newell married Esther Ramsland and they have three children, Thomas, Ellen and Edward.

The Boston Museum of Science has recently been the forum for a lecture, "The Making of a Weather Forecast for New England" given by **Fred Ward.** Fred is on the staff of the Air Force Cambridge Research Laboratories and was formerly a weatherman on TV Channel 7, Boston. He lives in Weston, Mass. . . . **Nat Sivin** has reviewed the book *Science and Engineering in China,* Vol. 4, in a recent issue of *Scientific American.* Nat is Associate Professor of Humanities at M.I.T.

Quite a lot of class news has come in with the class dues and reservations for our 20th reunion. **John Rydz** reports that he has moved to Scotch Plain, N.J. John has just joined Singer as vice president and technical director. . . . **Jack Larks** will be going to the M.I.T. Fiesta in Mexico City and hopes to see some classmates there. . . . **Ralph J. Preiss** says "Best of luck with the reunion. We can't make it since we're planning a European trip after an exhausting experience putting on "Rite of Spring," Stravinsky's much panned ballet with the Poughkeepsie Ballet Theater Co. My wife Marcia is production manager, and three of my daughters, Robin, Erica and Lisa have parts in it. My fourth daughter, Jacqueline, remains our ballet critic and I have a full-time job with I.B.M. on the staff of the director of advanced systems." . . . **R. W. Preisendorfer** is now research mathematician at the Institute of Geophysics, University of Hawaii. . . . **Alan Geisler** writes that after four years pending he expects to get approval for the use of a product in frankfurters. "The wheels of progress at the U.S. Department of Agriculture may not grind exceedingly surely, but you can depend on their being slow."

Charles W. Poppe writes, "Marily and I are looking forward to the reunion. We're hoping that final exams don't interfere with our son and daughter being with us. Charles, Jr., is a sophomore at Huntington High and spends much of his free time programming for their PDP-10 time sharing computer. Wellner, our daughter, is active in the Mathletes, the band and other activities at Simpson Junior High. I have been doing a lot of traveling as director of marketing for Hartman Sys-



J. B. Dixon, '55

tems Division of A.T.O. Inc. See you in June."

James Stolley writes that the reunion is on the same weekend as his daughter, Karen's, high school graduation. She is going to Argentina for a year on a Student Exchange Program and then on to Middlebury College. . . . **Gilbert B. Solitare** has assumed the position of chairman, Department of Pathology, Hospital of St. Raphael, New Haven, while maintaining his appointment as Associate Professor of Pathology at Yale University School of Medicine. Dr. Solitare has four children, Neal 14, Nancy 12, Kenneth 9, and Laura 2. . . . From **Bruce Curry** comes the following: "Joanne and I are looking forward to the 20th and hoping that it doesn't conflict with our son's high school graduation date. We are still living in Packanack Lake, N.J., and I am still with R.C.A. as staff vice president. My main job currently is convincing people that R.C.A. still uses computers even if we did go out of the computer business. . . . **Robert H. Norton,** C.L.U., has been honored by being named to the President's Honor Club of the John Hancock Mutual Life Insurance Co. The Club is an association of the firm's leading sales representatives and is meeting during March at the Princess Hotel, Pembroke, Bermuda.

Don't forget! We'll all be in Edgartown, Martha's Vineyard on June 2, 3, and 4. See you there.—**Arthur S. Turner,** Secretary, 175 Lowell St., Carlisle, Mass. 01741

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Spring is here at last, and we can look to the lighter and warmer things for awhile. **John M. Dixon** has recently been appointed editor of *Progressive Architecture,* a monthly magazine in the field of architecture, interior design, and urban planning. He lives in Brooklyn with his wife Carol, who teaches at Erasmus Hall High School, and children Peter and Susannah. John has been active in neighborhood civic activities and is a member of the A.L.A. He was the author of major portions of the *A.L.A. Guide to New York,* and last fall he received an award from the Shore Chapter of the New Jersey Society of Architects.

Two local classmates have been lecturing at I.E.E.E. meetings. **David Chesler** gave a talk on signal processing in nuclear medicine to the Boston Chapter of the I.E.E.E. Group on Information Theory, and **Joseph Tierney** spoke on the topic of digital frequency synthesis at the Boston Section I.E.E.E. lecture series in February. . . . **John Lindenlaub** has expanded his use of audio tutorial instruction methods at Purdue, and he was featured on the cover of the American Society of Engineering Education magazine last fall. John, his wife Debby and their four children lead an active life in West Lafayette, Indiana. Farther west, **Allan Boardman** continues to maintain a pace of work (at Aerospace Corp.), family (three children), and related joys to satisfy him.—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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Our reunion questionnaire indicated 21 own their business, and an additional 26 per cent would like to be self-employed. The marketing panel of the Boston Entrepreneurship workshop on March 4 was composed entirely of our classmates, all presidents of small companies. The introduction was given by class president, **William Grinker,** who acted as moderator. . . . **William Northfield,** President, Computer Devices, Inc., talked about product development. . . . **Martin Reiss,** President, Alarmtronics Engineering Co., Inc., discussed marketing through distributors. . . . **T. Guy Spencer,** President, Wellesley Community Playhouse, was concerned with the consumer, and **Ronald Massa** explained marketing of technical devices. Ron, formerly director, Space Systems Department, Avco, formed Dynatrend, Inc., last November. This management consulting firm has offices in Burlington and Washington, D.C. When interviewed, Ron said, "Business is brisk." The following week found **Bernhard Romberg** attending the M.I.T. seminar on starting a small business and making it grow. He is president of A.D.L. Systems, Inc., a newly created subsidiary of Arthur D. Little, which produces computer software.

Doretta Anne Klein, mother of three school children, was just elected to a term on the Arlington School Committee. Dr. **Arthur Frank** practices medicine in Washington, D.C. His brother, Dr. **Stuart Frank,** is a cardiologist in California. . . . **Curt Burrowes** began consulting a few years ago and is now president of Burrowes Research Co., Inc., in Concord. He has invented and manufactures electrical fiber plates, which are used in electrostatic printing and display systems. . . . **Caroline Disario Chihoski** takes great pride in her six children, ages 14, 13, 12, 10, 8 and 1 and in her husband Russell '54, who received a gold medal award for his work in welding research at the Martin Co., in Denver.

William Leitch recently organized a New York seminar, "The Computer Industry: New Directions in the 1970s." This meeting was held for financial analysts and was the most successful of its kind to date. Bill is vice president for subscription research services at International Data Corp. When he is not conducting research and special studies for the computer industry, he can be found home in Newton baking sour dough bread! Cosecretary: Mrs. **Lloyd Gilson,** 35 Partridge Rd., Lexington, Mass. 02173

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Plans for the Fifteenth Reunion of the Class of 1957 continue to gain momentum. Plan now to join your '57 classmates on June 2, 3 and 4, 1972 for an enjoyable weekend at the Provincetown Inn and Motel. The cost is $31 per person per day including room, all meals, taxes and gratuities. The reunion registration fee is $30 per couple or $18 single. Transportation is by air, ferry or family car.

A rather informal get-together is planned. Some of the highlights: free beer poolside, free Saturday evening predinner cocktail party, and a dance band. There will be ample time to visit with old friends and enjoy the many activities in and around Provincetown.

Don't forget that Alumni Day, June 5, follows our Reunion. The following are already planning to attend: Andrew Blackman, Dick and Nancy Blieden, Jay and Carol Bonner, Allen and Penny Burgess, John and Lynda Christian, Jerry and Isabel Collen, D. and Jean Colling, Jim and Anne Cunningham, Jack Currie, Gary and Carolyn Dischel, Ronald and Daly Enstrom, Harry and Lynn Flagg, Martin Forsberg, Alan and Phyllis Godes, Bob and Marilyn Heitman, Herbert and Naomi Heller, Alfred Hoch, Mal and Jill Jones, Ron and Pat Keefe, Fred and Betty Morefield, William and Josephine Salmon, Hank and Sue Salzhauer and Family, Carl and Carol Sandin, Jr., Gerald and Ann Saul, Howard and Janet Schumacher, John and Marcia Tiller, Jr., Elliot and Nancy Wolk, David and Nancy Wolsk.

For more information contact Reunion Chairman, James E. Cunningham.

Here are a few last notes before Reunion. First an apology to **Gerald Marwell.** I published intact his letter about his doings and his new book but forgot to include the name of the book—it's *Dynamics of Idealism.* The publisher is Jossey-Bass Inc., of San Francisco. . . . **Edwin Straehley** is now director of engineering at Systems and Computer Information Inc., with offices in Inglewood, Santa Ana, and at Vandenberg A.F.B. He is working toward an M.B.A. at the U.C. Extension in Los Angeles and has been teaching simultaneously at the U.C. Extension in Santa Barbara—a course in telemetry. . . . **Hal Shane** is now Chairman of the Mathematics Department at the Baruch College of CUNY. . . . **George Seiler** has joined W. R. Grace and Co., as director of finance and administration for the Vinyl Group. He lives in New York City. . . . **Don Aucamp** has been an Assistant Professor at the Southern Illinois University in Edwardsville, Ill., since June 1971—in the Management Science Department.

Bob Kruger has been elected president and chief executive officer of systems,

Science and Software, Inc., (S^3) of La Jolla, Calif. Bob joined S^3 in 1967, prior to that he was with the General Atomic Division of General Dynamics in San Diego and with General Dynamics/Astronautics in La Jolla. Bob received his Ph.D. in mechanical engineering from Tech. He is a member of the American Society of Mechanical Engineers; the American Institute of Aeronautics and Astronautics; Sigma Xi (national research honorary society); Tau Beta Pi (national engineering honorary); and Pi Tau Epsilon. He currently serves on the Safeguard Missile Structure Vulnerability Working Group of the Department of Defense. Bob has presented numerous papers to technical symposia, primarily in the fields of heat transfer and material response.

Systems, Science and Software is a diversified research and technology company, specializing in the development and application of scientific computer software to analyze the behavior of physical systems. . . . That's all for now. See you at Provincetown.—**Fred L. Morefield,** Secretary, c/o Mobil Oil Caribe Inc., P.O. Box X, Caparra Heights Station, San Juan, P.R. 00922

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Several letters this month from our ever-growing international contingent. The first one was from **Mike Balderston,** who announced that "after seven years with N.A.S.A., I will be moving to Melbourne, Australia with my wife and seven (count 'em-seven) children. I have a three year contract with the Australian Post Office working on satellite communications at their research laboratories." . . . Our second letter was from **Martin Victor** who is presently in England as commander of the U.S.A.F. hospital at Upper Heyford, near Oxford. He notes that "I have been called upon to do some public speaking here on everything from medical care in the U.S. to being in round-table groups discussing a wide variety of topics. Also find time to bowl and to referee in several sports. We are enjoying London trips and will probably be here one and one-half years more. The welcome mat is always out for M.I.T. visitors".

Robert Witte dropped a line telling us that he is "presently Commanding Officer, Base Portsmouth, Va. This base provides support for the Fifth Coast Guard District vessels, boats, and aids-to-navigation facilities. My previous responsibilities have included Technical Director of the U.S. Buoy Development Project, co-director of the Coast Guard's Field Testing and Development Center, and delegate to the International Life-Boat Conference, held every four years and most recently in New York in 1971. I have been involved in various rescue craft design, development and construction activities since 1963." . . . **Mel Copen** has stayed on in Washington as Director of the Office of Management Improvement in the U.S. Department of Agriculture. . . . **Robert F. Smith** is living in the Old Greenwich, Conn., area and reports a recent addition to their family—a second son, Duane. . . . **Chris Hahn** is currently Manager of Operations/Technical at the Princeton, N.J., plant of Shell Chemical where he notes that "the misplaced Westerners are managing to adapt." . . . **Cole Bess** is general manager of the Pilot Chemical Division of New England Nuclear. Cole, Judy, and their two daughters are living in Newton, Mass.

Melvin Haas was married recently to Elizabeth McFate and they are living in Silver Spring, Md. Mel is working in the Computer Systems group at the Naval Ship Research and Development Center in Bethesda. Elizabeth previously served as director of religious education at All Saints' Church in Winter Park, Fla., and is a graduate of both Boston University and the Episcopal Theological Seminary. Associates Corporation of North America has announced that **Jerry Flower** has been elected vice president of Associates Financial Planning and Control Company, Inc. Jerry joined Associates in 1970 after over six years in corporate planning and finance with McDonnell and Co., and General Finance Corp. . . . **Warren Heimbach** has been appointed vice president, plans and operations, for the Medical Products group of Litton Industries. Prior to joining Litton, Warren was with Mattell in a variety of posts including managing director of Rosebud Mattel in England.—**Michael E. Brose,** Secretary, 30 Dartmouth St., Boston, Mass. 02116

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Welcome back. We've got a lot of news to catch up on, so here goes. . . . A note from our ex-Secretary **Glenn Zeiders** is an appropriate one to start with: "You're doing my heart good missing a few notes now and then. It makes me feel continually less guilty about my sojourn as Secretary. Aside from that (common) fault, you're doing a great job. I've returned to Avco-Everett and am still involved in high-power laser development. The job gets a little frustrating at times but aerospace personnel have learned not to look a gift horse in the mouth!" . . . **Scott Latimer** writes that he is still working as copper department superintendent for American Smelting and Refining Company at the El Paso Smelting works. A short newsy note from **George Connor** —"My 33rd year—a lucky year according to the Japanese—maybe I'll even cease being a bachelor! I am leaving my current job as Division Chief, Radiation Physics Division, Defense Nuclear Agency to attend the Command and General Staff College at Fort Leavenworth, Kan." . . . In news from our barrister classmates, **Oliver Seikel** notified me that he is currently Legal Manager, International Operations, Midland-Ross Corp. Previously, he was a partner with the Cleveland law firm of Falsgrof, Reidy, Shoup and Ault. Oliver has also been made a trustee of his high school, Gilman Academy. . . . **Joe Mogilner** graduated from the University of San Diego School of Law last June, passed the California State Bar exam and plans to practice law in the San Diego area.

On the international scene, **Phil Beach** has returned to the food business as director of marketing for Borden, Latin America. Phil writes: "Great job—jetting around South American monitoring milk operations and investigating acquisitions in the food industry. The M.I.T. group has an active monthly luncheon, visitors welcome!" **Emile Battat** is vice president in charge of the foreign offices for the Kaiser Trading Co., and has been travelling quite a bit—particularly in the Far East and South America. Emile relates that the exposure to the various cultures and peoples has been most interesting and rewarding. . . . **Jerry Schooler** has joined A.T. Kearney Ltd., Management Consultants at their London office. . . . **German Otero** writes that he has formed an industrial consulting company called Ingenieros para la Industria in his native Venezuela. . . . **Al Baratoff** has accepted a two-year appointment with the Solid State Physics Institute in Germany. He feels it's one way to beat the Ph.D. rush which hasn't yet reached their shores! . . . Speaking of Europe, I spent a pleasant evening recently looking at slides of France and Switzerland from Barbara and **Ron Stone**'s Fall European jaunt—enough to make one rush home and pack one's bags!! Ron is presently assistant to the Dean of the Graduate School here at M.I.T. . . . Still on the academic scene, **Cal Gebhart** writes that he has been appointed Assistant Dean of students at Illinois Institute of Technology.

George Moss was recently appointed manager of the Engineering Acoustics Research and Development Program at the U.S. Naval Oceanographic Office. . . . **Fred Miercort** is currently with Lambda Corp., Arlington, Va., and **Harry Scherzer** has been made vice president of Marketing for the Consumer Products Group, Molded Products Division of the Amerace-Esna Corp. . . . **Syl Miniter** is presently working at I.B.M., Manassas, Va., managing a circuit development group in large scale integrated circuits for computers. He still has three children, a lovely wife and a desire to hear from some of our classmates.

Trying to keep track of our entrepreneurial classmates is becoming more and more difficult. I recently ran into **Chuck Staples** and **Dick Sampson** at the Faculty Club and was informed of their new company, Family Guard, Inc., which markets wireless fire and burglar alarms. . . . **Marty Zimmerman,** who founded Telco Marketing Services, Inc., in 1967 to engage in the rental and leasing of medical and scientific equipment writes that Telco is going public. Marty and his wife Rita have two children, Jacqueline (5) and Adam (2). **Carl Neu** has resigned his position with the Gates Rubber Co., to form his own company in the management consulting area. Carl, his lovely wife Carmen and two children are living in the Denver area and have kindly extended to me an open invitation to visit them and try my new found skiing expertise on the challenging Colorado slopes.

At the recent Honors Banquet of the Aerospace Sciences Meeting held in New York City, **Gary Plourde,** a project engineer for Pratt and Whitney Aircraft was co-recipient of the A.I.A.A. Goddard

Award as a member of a team which conducted original research leading to the first understanding of gas-turbine compressor stalls induced by turbulent inlet flow conditions.

On the stork front, I received a clever announcement heralding the birth of Bradford Douglas Bates to Lydia and **Brad Bates.** This was number three, number one is David (10) and number two Frances (8). Brad is with Honeywell Informations Systems in Framingham. Lydia writes that they returned to the East Coast four years ago after six years in California. She goes on "California is a great State but it's a little rough when three million other people think so too! ". . . Judith and **Leon Glicksman** announced the arrival of their aquarian—David William this past January. They are presently living in Peabody and Leon is still on the faculty of the Mechanical Engineering Department here at M.I.T.

Well, that's about it for now. I plan to be back sooner than the last time!—and keep those cards and letters coming.—**Arthur J. Collias,** Secretary, 61 Highland Rd., Brookline, Mass.

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As I promised I have been going over the old Sussman report on our Class when we were freshman in '57 and '58 to see how the results of that survey compared to the results of our tenth reunion survey. Well sad to say a lot of work is going to be required before a meaningful comparison can be made. A computer will have to be consulted and that is going to take time and money. Anyone in the class want to do it? I'll be glad to send off the questionnaires to anyone qualified to do the job. However a couple of things in the 1957 report do compare easily to our survey. As you recall we asked a question about how happy you remember being when you were a freshman. The '71 survey indicated that 51 per cent recalled being fairly happy. In 1958, 63 per cent said they were fairly happy. In 1971, 32 per cent said they recalled being "not so happy" while only 11 per cent said so in 1958. This could be due to a sampling error in 1971 or perhaps as the years go by freshman year seems more miserable than it was. Our 1971 survey indicated that by senior year 28 per cent recalled being very happy and 57 per cent, fairly happy. So the memories improve as the time becomes less distant. Ninety per cent of the Class now says that it is happy. From the Sussman report I learned that almost 70 per cent of the Class was more content than it was in high school.

It might be worth recalling that in a survey taken in the fall of 1957, 96 per cent of the Class said that it wanted to graduate in the top half of the class. Perhaps we are all congenital liars. As freshmen 77 per cent said that they would choose M.I.T. again while three more years of M.I.T. and ten years of post graduate life reduced this fraction to 68 per cent. An interesting change has occurred in our attitude on what is valuable about M.I.T. In August 1957 (before arriving on campus), 80 per cent liked that "high academic reputation." By May '58 only 21 per cent found that to be valuable. Now 13 years later more than 90 per cent indicated that the reputation was valuable. In a category called "excellence of curriculum" a really dramatic change occurred. In August 1957, 20 per cent said it was valuable; in May 1958 it was up to 36 per cent and now it is around 80 per cent. On the question of the importance of satisfying work (or studies) vs. outside activities the Class of '61 freshman felt that intellectual satisfaction was very important (about 75 per cent of the Class) and the tenth year reunion grad agreed (about 80 per cent).

The majority of the 1957-'58 freshmen felt that outside activities were only somewhat important while just half of us now think these activities are "very important." I don't really know what to make of that data—schizoids? Finally we seem to have forgotten how hard we studied when we were freshmen. The freshmen survey indicated that only 20 per cent of the Class claimed to have studied less than 24 hours per week. In retrospect we now find that 41 per cent says that they studied less than 24 hours.

Now getting to some mail accumulated over the last couple of months I see that **Fred Schmidt** had a boy last November 4 ("our third future taxpayer and defender of his people—we hope") named Erik William. . . . Another birth is recorded to **Charles Arcand Jr.,** who wrote, "Our daughter, Elizabeth Ann, arrived last July. Our son, Alan is just over two years old. I'm a professional pyromaniac; I light things and see whether they burn—i.e. my technical specialty is flammability and flame retardation. I'm also about two-thirds of the way through an M.B.A. program with emphasis on new venture management." . . . **Mike Leis** had a girl, I think it was, last January. I came across him pacing the floor near the delivery rooms at Boston Hospital for Women but never got the name. I also got a note from him the other day saying that he has a two year old boy named Peter. Mike works as a consulting engineer at Digital Equipment Corp., in Maynard, Mass. The Leis' live in a 200 year old house with lots of land and he says that that keeps them constantly busy. . . . The final social note comes from Captain **Roger Whitman** who was married last July to Theora Hoekstra (Calvin College A.B.'64). They met in Germany in 1967. Now they are back in the states at Fort Ord (in California) where Roger is a maintenance staff officer.

Quite a bit of moving about in the last couple of years. For example: **Gerry Staack** "switched jobs early in 1970 going to Boise Cascade. I am in the Composite Can Division which is headquartered here in St. Louis and have been manager of the engineering department with technical responsibility for our 18 plants since December 1970. . . . **Alan Cohen** began private practice in Neurology in Long Beach, Calif., last July. Since graduation he has spent his time in med school, internship, residency and in the Air Force. Now he can get down to making a living. Alan and his wife, Addy, have three kids; Lisa (6), Jason (4) and Tanya (2). They all apparently enjoy the weather, smog and all, in Southern California. Alan says he would like to hear from his old roommates **Bob Katz** and **Andre Willner.** His address and any others you want are available from me or the Alumni Office. . . . **John Warren:** "After spending the last two years in Chapel Hill, N.C., studying for a master's in city and regional planning, I received my M.R.P. last June. My wife, Sandy, and I returned to California where I am working as an urban planner with Santa Cruz County. We had a very pleasant two month trip westward with a detour via Boston, New England and Eastern Canada." **Charles Phipps** got his Ph. and D. last February and will be at the Livermore Radiation Lab in the laser fusion group until the money runs out.

Lee Fryer lived in Hudson, Massachusetts before moving with his wife, a son and a daughter. He says that since he switched from course 16 to 15 he did not get caught in the aerospace crunch. Nowadays he works for Digital Equipment Corp., as a field service financial manager. . . . One last mover, **Bill Grimmell,** adds, "My wife, Barbara, whom I met at the University of Michigan, my daughter Lisa (3) and I moved to what is our first house in Parsippany, N.J., in 1970. I have been working as a senior mathematician at Hoffman LaRoche Inc., since leaving Bell Labs in 1968. My title is somewhat deceptive, for while my major responsibility is directing a computer process control project, I have designed interfaces for optical sensors and am about to embark on the development of special purpose computer peripherals."

Finally we have a mover on the social front. It is the formidable **Sue Lippman** who wrote, "Lloyd and I are pleased to note the more even-handed approach to women applicants to M.I.T. as evidenced by the increased number of women enrolled this year. I am now working with N.O.W. (National Organization for Women) and W.E.A.L. (Women's Equity Action League), affirmative action programs for nondiscrimination in *hiring,* we hope will improve the faculty situation." No comment from **Andrew Braun,** 464 Heath St., Chestnut Hill, Mass. 02167

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Lewis M. Norton and his wife Judie have a second son, David Mark, born April 29, 1971. . . . August 18, 1971, brought **Don Nelson** and his wife Barb a second daughter, Jody Lynn. He is still with Union Carbide and is working in Industrial Engineering. After nine years he has returned to campus life starting on his M.B.A. last fall. . . . **Rudolph H. Gawron**'s wife Jean delivered a son last January. He reports that, "the proud parents are doing well." . . . **David E. Nickles** has a new addition in his family, Karen Joan, born July 27, 1971. David has transferred to the manufacturing section of Dupont's Building Products Division and is currently manufacturing supervisor in charge of Corian (DuPont's synthetic marble), casting area. At last, he reports, he and his wife have completed remodeling their 40-year-old English tudor house. . . . On May 26, 1971 the University of Colorado

presented the degree of Doctor of Philosophy to **Lyle Oliver Hoppie** for his work in the field of Electrical Engineering. The title of his thesis was "A 94 Gighertz Quasi-Optical Traveling-Wave Maser." His previous accomplishments include: M.S., 1968, University of Colorado, B.S., 1962, M.I.T.

Jerome E. Manning was among lecturers presenting a special seminar "Acoustics and Noise Control in Buildings", held in Cambridge, Mass., on February 24, 1972. Jerome is currently the course co-director and a principal of Cambridge Collaborative, a consulting firm active in acoustics and noise control. . . . **Earl Ruiter** visited Caracas, Venezuela from January 5 to 13, 1972, to consult with the Venezuelian Ministry of Public Works on national transportation planning. His stay included a weekend in Caracas where he enjoyed the climate and sightseeing. . . . **Donald M. Dible** is the author of the current best selling book *Up Your Organization.* The book has received flattering reviews from all sides. . . . (A. Hassitt or **L. E. Lyon**) co-authored a recently published article entitled "Efficient Evaluation of Array Subscripts of Arrays." The article describes an efficient method of evaluating subscripted expressions in the high-level computer language A.P.L.

Nicholas H. Charney, former chairman of Boise Cascade's C.R.M., Inc., subsidiary, recently purchased the *Saturday Review* magazine and the trade books division of the McCall Publishing Co. *Saturday Review* has a weekly circulation of more than 600,000, while the McCall trade books division published some 80 titles last year. . . . **Dick Stein** has been promoted from associate professor to professor of physiology at the University of Alberta. After serving last year as the acting chairman for the department he says he is happy to be able to devote all his time to research and training. He also is the author of over 30 publications. . . . **David H. Bragdon** is spending his second year at the Well School, a new "alternative" high school located in Peterborough, N.H. David not only teaches full time, but also "coordinates" the high school. . . . **Jose A. Rionda** is currently employed by the Esso Research and Engineering Co., in Florham Park, N.J. In *Mechanical Engineering,* December 1971 issue, he is noted for his recent work in surveying the several processing routes now being employed by refiners in so far as fuel oil desulfurization is concerned.

That's all for now, folks.—**Gerald L. Katell,** Secretary, 122 North Maple Dr., Beverly Hills, Calif. 90210

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This month brings quite a nice letter from **Hank Lichstein** but very little else. The rest of you, get busy! Hank reports that son Daniel is now six months old and weighs 19 lbs. Wife Janine is back to dancing, fitting it in between her housewife and mother's chores. Hank spends some of his time outside work throwing pots on the wheel in a ceramics class. He is still at First National City Bank heading up a small section with responsibility for analysis of domestic assets and liabilities and overall institutional earnings. Hank says he works long hours, spends some time on the computer, makes a few presentations, and generally has a good time. Hank works regularly with Paul Rudovsky ('66) and sees **Howard Ellis** occasionally. According to Hank, Howard is pursuing a career as a teacher (evenings) and independent consultant on environmental pollution problems. Howard works in New York City and lives in New Jersey.

Ralph Cicerone sent along a note to say that he is continuing in atmospheric and ionospheric research at the University of Michigan. . . . **Leonardo Peusner** is now a member of the Research and Development Division Staff at Arthur D. Little, Inc. Leonardo will be involved with biophysical and biomedical research and health care delivery with particular emphasis on sickle-cell anemia and related disorders. Leonardo received his Ph.D. in biophysics from Harvard and was a research fellow at Harvard Medical School before joining Arthur D. Little. . . . **Richard Sramek** published an observation in the *Astrophysical Journal Letters* last July tending to support the gravitational theory of Brans and Dicke over the general relativity theory of Einstein.

Peter Sexton is studying for a Ph.D. in metallurgy at the University of Aston in Birmingham, England. Peter spent a month late last summer touring Eastern Europe and Turkey. . . . **Ka Bing Yip** received his Ph.D. from CalTech in 1971 and is now doing research in ionospheric physics at Jet Propulsion Lab at Pasadena. He was married in June, 1971 to the former Miss Phyllis C. F. Lee.

I've seen several classmates in my recent wanderings and will take a few lines to report on them. **Bob Fiske** and I now share an office at Mitre. Bob is very active in skiing and bridge tournaments, and is one of our remaining bachelors. . . . **Bill Inglis,** another bachelor, has bought a house in Arlington, Va. Bill is a civilian employee of the Defense Communications Agency's Joint Technical Support Agency. . . . Gladys and **Jim Taylor** have a nice house in a new development north of Houston, Texas. Their young ones, Kimberly and Jeffrey, seem to be thriving on the Texas environment.

That's it for the month. For a larger column, send more letters.—**Steve Lipner,** Secretary, 3703 Stearns Hill Rd., Waltham, Mass. 02154

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It is such a fine day in the San Francisco Bay Area that I decided to sit outside in the sun while writing this month's news. Hopefully, even Boston weather will be reasonable by the time this appears in print. I happily note that ten days of vacation are now staring me in the face; things are not too tough. . . . **Neal Gilman** is in medical school at U.C.L.A. His claim to fame is treating Groucho Marx for stomach trouble. He really had Groucho in stitches. . . . **John Child** is in his second year at University of Pennsylvania Law School. He is also trying simultaneously to complete work on a thesis for a B. Litt. in politics at Oxford University in England. . . . **Bill Brown** is a senior development metallurgist at Hitchiner Manufacturing Co., in Milford, N.H. He has taken up skiing with his wife Joy and their three-year old Billy. . . . **Philip Rosenkranz** received his Ph.D. from M.I.T. in August. He lives in Pasadena and is a research associate at J.P.L.

Tom Brownscombe expects to receive a Ph.D. in organic chemistry from Rice in May. He hopes that he will not be added to the ranks of unemployed chemists. . . . **Louis Offen** has returned to University of Maryland Medical School after a one-year leave of absence in Columbia, S.A., where he studied human malnutrition. He will graduate in June and then do a straight medical internship. Louis spent the summer of 1968 in Europe; he was working in a hospital in Czechoslovakia during the Soviet invasion. He writes that graduation will bring a shocking end to childhood and long vacations. . . . Mary Kay and **Rod Peterson** bought a house in Virginia last year. In September they visited Ann and **Don Partridge** and **Dave Mechler** in Philadelphia. Don is in Seattle in his third year of graduate study in neurophysiology at University of Washington. Dave toured Eastern Europe last May and June with University of Pennsylvania Glee Club. He spent the summer at Applied Physics Laboratory of Johns Hopkins University. He is now in his second year in electrical engineering at University of Pennsylvania. Last December he married Esther Rosenthal of Philadelphia. Esther has a B.A. from Bates and a M.A. from University of Rochester and is a guidance counselor in the Philadelphia school system. Dave writes also that **Lock Kuhn** is living and working in Washington, D.C., where he and his wife Coralee welcomed a baby girl last November. . . . **Terry May** is out of the army and has received his M.B.A. from U.C.L.A. . . . **Gerald Siegel** received a Ph.D. in operations research from Cornell in December. In October he began working for Esso Math and Systems in Florham Park, N.J. He lives in Morris Plains, N.J. . . . **Alexander Pitegoff** married the former Linda Gold March 14, 1971.

Joan and **Larry Greenberg** proudly announce the October birth of their second daughter Marissa. Larry is now in his fourth year of graduate work in astrophysics under Charles Townes at Berkeley. . . . Having worked three years at M.I.T.R.E. Corp., **Roy Gamse** is back at Harvard Business School for his second year. He is looking for a job concerned with public policy formation. . . . **Philip Manly** is married and the father of three children. In June, 1971, he received an M.S. in environmental engineering from R.P.I. He works as a radiation control engineer at Peal Harbor, where they refuel nuclear subs. He also has been enjoying teaching technical matters. . . . **Stephen Metz** is still in the navy at Navy Research Lab in Washington, D.C. . . . **Richard Zinner** is practicing law as an associate with the Boston firm of Friedman and Atherton. . . . **Larry Banks** is building a house in Burlington, Mass. He is working at Hewlett-Packard Medical

Electronics Division and looking forward to projects involving more travel. . . . Joan and **Larry Constantine** recently finished an 11,000-mile auto trip in connection with their research on group marriage.—**Jim Swanson,** 508 Thompson Ave., Mountain View, Calif. 94040

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We are slowly getting used to being suburbanites after living so many years in scenic Cambridge. The past two weekends have been spent tilling the good earth in the hopes that we will have crops by the end of the summer. The house came with 12 fruit trees, but we don't know what they are so I guess we'll just have to let nature follow its course and see what comes.

We recently bumped into **Rich Lufkin** while we were shopping at the Cameron Station Commissary (reportedly the world's largest supermarket). Rich has returned from the seagoing navy and is finishing his tour in Washington trying to improve the moral of the navy. . . . **Gordon Logan** writes that he is still flying for the Air Force. He and his wife recently returned from two months T.D.Y. in Europe; one month of which was spent travelling all over. Gordon reports seeing **Dave Dimlich** who was enroute from L.A. to D.C. for a job transfer. . . . He also reports that **Stan Gottschalk** is now an Australian citizen by marriage and plans to receive a Ph.D. in June from the University of Melbourne.

From our old friends of the "Selling of the Pentagon" fame, the Army Home Town News Center, comes word that Private **George D. J. Phillies** "recently completed a 10-week medical corpsman course at the U.S. Army Medical Training Center, Ft. Sam Houston, Texas. He learned to perform routine patient care and treatment duties in combat areas, hospital units, dispensaries, clinics, and other medical facilities. He also received instruction in the transportation of sick and wounded by ground, air, and water means." . . . From Iran, **Vahe Davidkhanian** writes that he has completed his military services successfully and hopes to visit M.I.T. in 1973. . . . **Curtis Blaine** reports that he and **James Marshall** visited the 'tute in November and were impressed by the new colorful look which has replaced the sacred gray walls. They wished that they had been around when the Engineering Library was renovated. Jim is now living near Philadelphia. . . . The remaining news comes from our class's international business community. . . . **Richard Henderson** is still working for the First National City Bank in South Africa. On September 1, 1971 he and Sue had a son, David. They describe the experience as "noisy but kind of groovy." . . . In November 1971 **Philippe Dumortier** was transferred to the Group Planning Division of Shell International Oil Co., Ltd., in London. He expects to be there for the next two or three years. . . . Also in the oil business is **Roland Goffrois** who is a project engineer at the Compagnie Francaise des Pétroles.

That's all we have for this month. Gail and I will be back on campus for graduation in June and we hope to see a lot of people then—**Gail** and **Mike Marcus,** Class Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

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We are sorry that the column isn't of its usual length, but class mail hasn't been exactly overburdening the mail room staff. We have heard from **William Michaels,** who after having received graduate degrees in computer science and information systems, is working for Technology Management in Cambridge as a consultant. . . . **Robert Bowden** will leave Honeywell this fall to attend Harvard Business School. He plans to wed with Martha Melican in August. . . . Working for the U.S. Public Health Service in the Environmental Protection Agency in the state of Washington is classmate **Robert Dangel.** He relates to us that the E.P.A. is suffering disorganization pains, but that the mountain climbing is excellent and that there have been nine clear days since October 15. We got a nice little note from **Cynthia Helgerson** Bloomquist telling us of her marriage last August to Ken, in a garden wedding at his parent's home. They spent their honeymoon camping in the New Brunswick-Newfoundland region. Ken is studying at Boston University, while Cynthia is working on M.I.T. Admissions staff.

Second Lieutenant **Michael Venturino** has been awarded his silver wings after successfully completing U.S. Air Force pilot training. He will be stationed in California serving in the Military Airlift Command. . . . **Michael McNallan** has been promoted to Army Specialist Four while serving as a clerk with the Ninth Field Artillery at Fort Sill, Okla. . . . **Bennie Ward** has been awarded a master's degree from Princeton. He had received Bachelor's degrees from M.I.T. in Courses VIII and XVIII. . . . **Tyler Thompson** is working toward a Ph.D. in organic chemistry at University of Illinois on a University Fellowship. Evidently, musical activities in which Tyler engaged in as an undergraduate have had to be abandoned for the pursuit of chemistry.

Had a nice lunch and discussion with **Ralph Cole** who is working for a housing development firm, Continental Wingate. He is very enthusiastic about his work and travelling. In our conversation, Ralph related how he had performed volunteer work for Robert Hagopian in the Alumni Office. He said that this kind of contribution to the M.I.T. community was important especially in the years just after graduation. We wholeheartedly agree, and hope that any of our classmates who are interested will please contact us or the Alumni Office.—**Laura Malin,** Secretary, 406 Beacon St., Apt. 1, Boston Mass. 02115; **Robert Vegeler,** Class Executive Committee, 511 Beacon St. A-9, Boston, Mass. 02115

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This is a disclaimer. If people would send us blurbs about themselves, we could stop fabricating these things. For this month's fantasies: **Cathy Buckley** was elected to be a representative to the Town Meeting in Dedham. She is currently soliciting pictures of Frank Sinatra and Judy Garland for her collection. If you have any spares, please send them c/o Howie. . . . **Hank Vaccaro** is attending grad school in M.I.T.'s Civil Engineering department. He is working in the Urban Systems Lab. . . . **Tom Pipal** is in a Ph.D. program in management at Northwestern University. . . . **Jerry Kardas** is getting married to Jan Kleeman, a Wellesley graduate. . . . Hippy-radical **Rick Coke,** having spent last year using up his savings, has been forced to cut his hair and look for a job. He graduated with a degree in metallurgy. . . . **Larry Rosenblum** is at Stanford studying chemistry . . . **Raisa Berlin** is in the political science department at M.I.T. . . . **Larry Storch** is now at Harvard Law School.

Kerry Mull was last seen heading for Denver, Colo. . . . **Ed Grossman** is head staff member of P.I.R.G., a public interest research group in St. Louis, Mo. . . . **Marvin Kluttz** is at M.I.T. in aeronautics. . . . **Ann Kivisild** Smith is teaching French in Wellesley. . . . **George F. Providakes** is a second lieutenant in the army, currently stationed near New Ulm, Germany. . . . **Gary J. Felser** graduated from M.I.T. last January, receiving B.S. degrees in IV and XI. His thesis was about mobile home parks. . . . **Ken Wayne** is in graduate school at M.I.T.'s Sloan School. . . . **Mary Ellen Owre** is attending B.U. Law School. . . . **Randy Hawthorne** is at Harvard Business School. . . . **Bob Bendler,** the original phone hacker, switched his area of operations from New England Telephone to California Bell. He is attending Stanford. . . . **Ray Huey** is still at M.I.T., in the Sloan School. . . . **Donald T. Black** is now a private in the army. He has recently completed eight weeks of basic training at Fort Leonardwood, Mo. . . . The finest beer drinker in M.I.T. history, **Chris Marler,** married Cynthia Kenney of Wellesley. They are living in Chicago, where Chris is working for International Harvester and Cynthia is attending the University of Chicago, studying biophysics.

Nicky de Cristofaro is attending graduate school in metallurgy at M.I.T. . . . **Dick Schwartz** got married and is in the Navy Reserve. . . . **Lawrence Keefe** will be going to England to do graduate work at the University of South Hampton. . . . **Mark Pasternak** is attending Harvard Medical School. . . . **Neal Sattan** and **John Halperin** are in the Harvard-M.I.T. Joint Program in Health Sciences and Technology. . . . **Andy Kolbeck** will soon receive his master's degree in metallurgy, and will continue for his Ph.D. His wife Bernie is working in the Kendall Square branch of the Harvard Trust. They met sailing the Milwaukee Clipper across Lake Michigan. . . . **Wells Eddleman** lives and still wears tennis shoes.

Keep those cards and letters coming in, folks.—**Howard Jay Siegel,** President; and **Leah H. Jamieson,** Executive Committee Member, 26 Peverell St., Apts. 1 and 2, respectively, Dorchester, Mass. 02125

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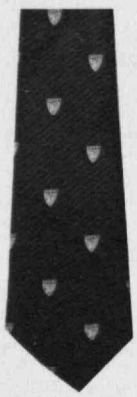

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TR-71

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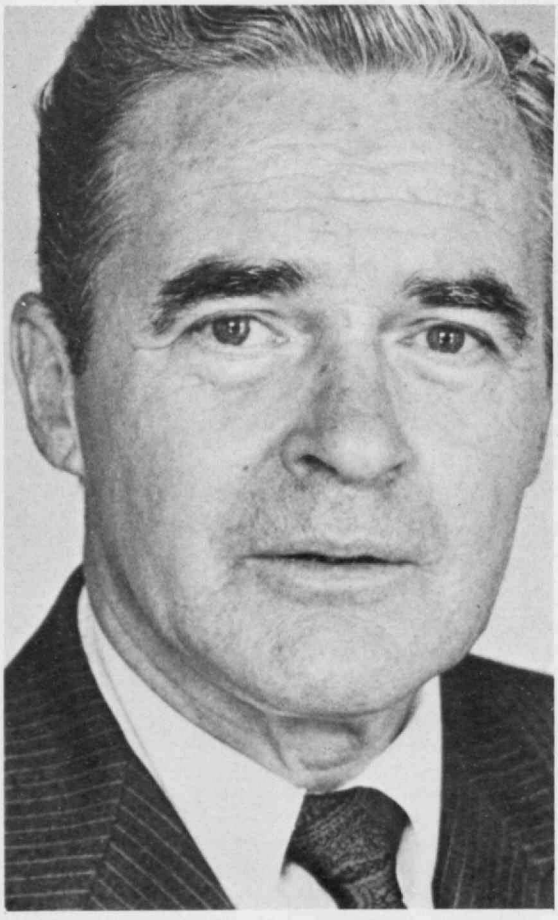

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